Continuing Professional Development | Business Success | Clinical Skills

vet 360

Vol 08 | Issue 03 | July 2021

Anaesthesia

Anaesthesia for the Geriatric Patient

Surgery

Upping your Lateral Suture Game

CPD Article

Managing Pericardial Effusion in the Dog

Artwork by Tango.
Movement by Onsior™ (robenacoxib).

New indication for use!

onsior™
(robenacoxib)

Manage your patients' pain so they can fully express themselves.*

Onsior™ 6 mg tablets for cats are rapidly absorbed for fast onset of action, providing effective treatment of pain and inflammation associated with surgery and musculoskeletal disorders in cats. Robenacoxib from each flavoured, once-a-day tablet clears quickly from the blood, yet persists at the site of inflammation to deliver relief where it's needed most. Trust Onsior™ 6 mg tablets to inspire more movement in your feline patients.

Onsior™ 6 mg tablets: For the treatment of pain and inflammation associated with **acute or chronic musculoskeletal disorders** in cats. For the treatment of pain and inflammation associated with **soft tissue and orthopaedic surgery** in cats.

* Please refer to the package insert for details

S4 ONSIOR™ 6mg Tablets for Cats: Reg. No. 07/3.1.2.2/22 (Act 101 of 1965). Each tablet contains 6 mg robenacoxib.
S4 ONSIOR™ Injection: Reg No. 07/3.1.2.2/23 (Act 101 of 1965). Each ml contains 20 mg robenacoxib, 0,05 % m/v of sodium metabisulphite.

Registration Holder:
Elanco Animal Health (Pty) Ltd. Reg. No: 2019/163893/07.
N1 Business Park, Old Pretoria Road, Kosmosdal Ext 7, Gauteng, 0157. Tel: +27 12 657 6200.
Onsior™, Elanco™ and the diagonal bar logo are trademarks of Elanco™ or its affiliates.
PM-ZA-21-0089.

Elanco™ Helpline: 0861 777 735

Elanco™

Editor's Note

Well, we are riding the crest of the third wave. I'm writing this while having a Covid positive husband and awaiting my own test results. You just can't trust a sore throat these days.

I am sure the impact is severe for all of us, but we just have to "byt vas" and follow through. I wish everyone the best as they keep on going, and my condolences to those who have lost friends and loved ones to this infection.

This edition continues on the pericardial effusion track. I believe this condition can present as a true emergency when there is cardiac tamponade and it is important for vets to be able to manage it and treat it if push comes to shove in an emergency situation. There is also an excellent article on imaging of the nasal passages and sinus cavities . CT may be the gold standard but it is as yet not readily available - so let's make sure we know what to look for using old and tried methods.

Keep safe.

Liesel

Index:

Vet360 is a source of current, relevant educational material for practising veterinary professionals in Southern Africa.
Published Bi-monthly in hard copy and electronically on www.vet360.vetlink.co.za.

Distribution: Southern Africa, 3 500 copies.

Editor: Dr Liesel van der Merwe BVSc (Hons) MMedVet (Med) Small Animals.
Layout and design: Heinrich van Rijn
Publisher and Owner: Vetlink Publications
Other Publications by Vetlink: Vet360 Mobile App, Livestock Health and Production Review, Hooo-Hooo, Equine Health Update

We welcome any comments, contributions, topic suggestions and letters for publication. Send them to:
The Editor, PO Box 232, GROENKLOOF, 0027
Tel: (012) 346 1590, 082 575 6479. Fax: 086 671 9907
Email: lieselvdmvet@gmail.com
(Dr Liesel van der Merwe)

Publisher: Madaleen Schultheiss: madaleen@vetlink.co.za

Advertising Enquiries: AgriConnect
Ilse Liveris
Senior commercial consultant
072-708-4401 / ilsel@agriconnect.co.za

Soekie du Toit
Commercial consultant
078-947-6916 / soekie@agriconnect.co.za

We are currently distributing to SAVA members. A win-win situation for SAVA, Vetlink and the reader. Please to subscribe to ensure access to the CPD MCQ. Subscription: www.vet360.vetlink.co.za

Working ON, Not JUST IN, Your Practice

Peter Weinstein, DVM, MBA
PAW Consulting
Irvine, CA

In his breakthrough book, The E Myth Revisited, Michael Gerber notes that most small business owners are technicians that had an entrepreneurial seizure; that they created a job not a business; and that without understanding HOW to run a business the business runs them.

Furthermore, and this is very evident in the veterinary field, just because you are a great doctor or clinician doesn't mean that you can run a business that delivers clinical care. Being a technician that is a good doctor doesn't guarantee being a good businessman.

Technicians work IN their business doing the things that they were trained to do. Entrepreneurs work ON their business each day, everyday, moving it forward and closer to their ultimate vision.

Every practice to be successful must have a vision defined by its leadership; core values that direct how things will be done; a mission that defines why everything is done; and standards of care that provide a foundation for patient care.

There are four foundational pillars that are built upon the practice leadership. Leadership is the bedrock within which these pillars stand. Without any one of these pillars, a business, a veterinary practice, will be unstable, unpredictable, and inconsistent in everything that it does.

The Four Pillars are:

1. Values
2. Vision
3. Mission
4. Standards of Care

CORE VALUES answer the question, "How will we behave as we work together?" These are the principles under which EVERYTHING is done by the leadership and the team!!

They are the fundamental beliefs of the practice and thus should be built as a team. These values will support you vision and mission statement but are actively lived each day in practice. They should be used to hire people. They can be used to fire people. Essentially, in your practice, they will help you to clearly define what is right and what is wrong. They act as a guide for decision-making.

A staff meeting or two or more may be needed to clearly define your values. Terms frequently seen in core values include:

- Respect
- Integrity
- Education
- Caring
- Passion (or Compassion)

The goal is about 5 to 7 easily remembered and easily recited Core Values. These values are not a secret and should be readily shared with clients. This puts them in the forefront of the team.

Once established core values should be inviolate!!

VISION STATEMENT answers the question, "Where are we going?" Your personal vision and business vision are like hand in glove. What will your practice look like at its optimal performance AND how will this help you accomplish your personal goals and visions.

By knowing what you want to accomplish personally, you can create a business to deliver for you what you want. NOTE: your business should deliver your life vision NOT the other way around. If your life is all wrapped up in your business that needs to change Your vision is your GPS target, your navigational beacon towards which you steer your business.

Your personal vision statement captures what you want to be, do, feel, think, associate with, and impact by some date in the future. It is closely aligned with your core values.

Your personal vision statement guides your life and provides the direction necessary to chart the course of your days and the choices you make about your career

Your personal vision should touch upon:

- Work and career
- Finances
- Recreation and Free Time
- Health and Fitness
- Relationships
- Personal Goals
- Contribution to the community

For your business, where do you see your practice at its optimal in the following areas?

- Financial
- Staff
- Physical Plant
- Free Time
- Management
- Exit Plans
- Community

A vision statement is a very personal statement and is developed by the owners, with some assistance from the leadership. It is what you see your practice looking like when it is delivering your mission. Your team MUST know your vision to be able to help you deliver on it. Don't keep it a secret.

To quote Michelangelo:
"The greater danger for most of us is not that our aim is too high, and we miss it, but that it is too low, and we reach it."

MISSION STATEMENT describes the sense of purpose that a leader and their teamwork under. It answers the question: "Why are we here?"

Steven Covey describes a mission statement as 'connecting with your own unique purpose and the profound satisfaction that comes from fulfilling it'. A mission statement should be what motivates you and your team to work to your peak performance. It is what motivates you to get up in the morning, go to work and make a difference.

Your team can be involved with the development of the mission statement, or you can develop it independently. It tells everybody why you do everything that you do. It is something that should be shared in the practice, with the clients, on your website, on the walls of your lobby, etc.

In many ways, your mission statement is your reason for existing. It is the legacy you want to have when you retire. How do you want to be remembered?

STANDARDS OF CARE answer the question, from a clinical standpoint, "How will we do it here?"

In a practice or community, a standard of care declares what an average physician would customarily or typically do in similar circumstances. In a multi-doctor practice (or even a single doctor practice), having a consistent manner by which cases are handled helps the doctors and the staff and ensures that the clients and patients aren't receiving mixed messages from the same hospital.

Do you have different vaccination protocols for each doctor? What about pain management? Is it an option or a requirement? Compliance is influenced by having a predictable standard.

The doctors and technical staff define standards of care. Ten of the most common standards of care based upon VHMA surveys are:

- History taking
- Pain management
- Vaccinations
- Exam frequency
- What to include in the Physical Exam?
- Spay/Neuter
- Fecal exam recommendations and Heartworm tests
- Flea and tick prevention
- Pre-anesthetic testing
- Surgical monitoring

Creating consistency amongst your doctors sends a very strong message to your team about the importance of care that you deliver. Different opinions are encouraged but compromise is a necessity to define a standard.

One final thought on delivering consistent care—create Medical Protocols.

MEDICAL PROTOCOLS are a detailed written set of instructions to guide the care of a patient or to assist the practitioner in the performance of a procedure.

Protocols define the minimum accepted data base or treatment protocols that your practice agrees upon There are so many similar presentations that you see every day. Why are there different approaches by the same doctor or different doctors? Protocols define how we do it here when a patient presents for:

- Chronic vomiting old cat
- Limping rear leg young dog
- Coughing old dog
- Annual visits
- Acute diarrhea young dog
- Etc.

These protocols can readily be stored on the computer or in a binder. They are easily translated into healthcare plans; treatment plans or estimates. They help save money by having agreed upon pharmaceuticals. They help generate money by encouraging more thorough workups. They guarantee consistency between doctors. They prevent clients from looking for the cheap doctor vs the expense doctor; the doctor who gives injections vs the doctor who does diagnostics; etc. The ultimate success of your business comes from the leadership supporting the four pillars of values, vision, mission, and standards of care. These pillars will determine the culture under which your practice operates.

The foundation then supports all the other systems that your practice will develop to provide a consistent client experience; a consistent patient experience; a consistent staff experience; and a consistent management experience. All of which allow you to have a business and not just a job and the ability to work ON not just IN your business.

Online Business Workshop with Eric Garcia & Dr. Peter Weinstein

SAVE THE DATE

OCT. 13

- RETENTION MARKETING- Hanging On To Your Clients For Life by Eric Garcia
- Hot Trends in Social Media by Eric Garcia
- It's All About You! Live Audit of Your Digital Presence by Eric Garica
- WONJI- Working ON, Not JUST IN Your Practice by Dr. Peter Weinstein
- SYSTEMS- YOUR RECIPE FOR SUCCESS by Dr. Peter Weinstein

Most practices exist in continued state of chaos. Everybody goes about their business with no direction, no communication, and no organization. Based up the teaching of Michael Gerber in the E-Myth and the E-Myth Veterinarian, this workshop will teach you how to work ON your business not just IN your business. From the vision to the organization chart and the operating procedures needed to provide a consistent client, patient, and staff experience, attendees will leave understanding that a system is the solution

Objective 1 Create a vision for your business that supports the vision you have for your life.
Objective 2 Create the systems for the business, in all areas, that provide a consistent experience for the clients, patients, and staff.
Objective 3 Learn how to work ON your business.

Dr. Peter
WEINSTEIN

Dr. Peter Weinstein attended Cornell University undergraduate and the University of Illinois to receive his DVM. After graduation, he worked as an associate for three years before opening his practice. As he was running his practice he identified the need for increased business acumen to make his practice successful. Thus, while managing and practicing full time, he attended University of Redlands to receive his MBA.

As a result of the MBA, he was able to relocate, expand and sell his practice to a corporate consolidator. Politically, he served as President of the Southern California Veterinary Medical Association and the California Veterinary Medical Association and President for VetPartners, the national consultants association. Currently he is Chair of the Veterinary Economic Strategy Committee of the AVMA's Veterinary Economics Division

In the veterinary industry, he acted as Medical Director overseeing the Claims Department for Veterinary Pet Insurance.Dr. Weinstein has provided small business and corporate consulting via his company, PAW Consulting. Presently, Dr. Weinstein is the Executive Director for the Southern California Veterinary Medical Association. Dr Weinstein lives in Orange County, California with his wife Sharon, two daughters (one a veterinary student at Oregon State), two dogs, and Bazinga, a Senegal parrot. Dr. Weinstein has spoken and written extensively on practice management, team building, leadership, collegiality, marketing, and other topics focused on making the veterinary profession better for all those affiliated with it.

He was the 2018 Speaker of the Year for the Western Veterinary Conference Practice Management Section. And is the Chair of the Veterinary Economics Strategy Committee of the AVMA. Most recently, he co-authored with Michael E Gerber, "The EMyth Veterinarian- Why Most Veterinary Practices Don't Work and What to Do About It".

Eric
GARCIA

When it comes to helping veterinary practices streamline their technology and attract and retain clients, Eric Garcia has a proven track record of educating the industry and producing results.

Eric is an internationally recognized IT and Digital Strategist working exclusively with veterinary practices. In addition to a long list of satisfied clients, Garcia's work has been recognized throughout the industry. Eric was voted VMX Speaker of the Year by conference attendees. He speaks regularly at conferences all throughout the world.

SPONSORED BY

ivpd

Hill's Transforming Lives

A new development in short- and long-term management of stress and anxiety in cats and dogs

PEPTAZINE (Fish Protein Hydrolysate)

A hydrolysed peptide with benzodiazepine-like effects, promotes increased levels of GABA.[1]

L-TRYPTOPHAN

L-Tryptophan is a precursor of serotonin, shown to control behaviour, mood, aggression, depression and stress.[2]

L-THEANINE

L-Theanine increases the levels of GABA, serotonin and reduces cortisol and noradrenaline levels.[3,4]

CalmEze® PLUS

Reg. no. V32391 / V32392 / V32393 / V32394 Act 36/1947
Manufactured by CF Pharma Ireland Ltd.
Marketed and Distributed by Ascendis Animal Health (Pty) Ltd.
31 Georgian Crescent East, Bryanston, Johannesburg, 2191
Tel: 0108800778 E-mail: vet-info@ascendishealth.com CAL.21.02/1

CalmEze® PLUS | Ascendis ANIMAL HEALTH

References:
1. Bernet, F., Montel, V., Noël, B., & Dupouy, J.P., 2000. Diazepam-like effects of a fish protein hydrolysate (Gabolysat PC60) on stress responsiveness of the rat pituitary-adrenal system and sympathoadrenal activity. *Psychopharmacology*, 149(1):34–40. 2. Horwitz, D.F. & Mills, D.S., 2009. *BSAVA manual of canine and feline behavioural medicine*. 2nd ed. Gloucester: British Small Animal Veterinary Association. 136–249. 3. Bryan, J., 2008. Psychological effects of dietary components of tea: caffeine and L-theanine. *Nutrition Reviews*, 66(2):82–90. 4. Sechi, S., Di Cerbo, A., Canello, S., Guidetti, G., Chiavolelli, F., Fiore, F. & Cocco, R., 2017. Effects in dogs with behavioural disorders of a commercial nutraceutical diet on stress and neuroendocrine parameters. *The Veterinary Record*, 180(1):18.

Anaesthesia for the Geriatric Patient

Molly Allen, DVM, DACVAA

Because the risk for anaesthesia-associated complications increases in patients with advanced age, a thorough pre-anaesthetic assessment and patient stabilisation and monitoring are required for the best outcomes.

Advances in veterinary medicine have improved longevity in companion animals,[1] and the geriatric anaesthesia caseload is increasing. A patient may be considered geriatric when it has completed 75% to 80% of its expected life span, which varies by species and breed.[2] A large number of geriatric patients present with comorbidities that must be considered during anaesthetic planning, but many have no known systemic disease.

Nevertheless, even "healthy" geriatric patients have a decreased functional capacity to respond to stress that does not become apparent until anaesthesia and surgery. To avoid unexpected poor outcomes, anaesthesia for all geriatric patients must be approached with special consideration of their altered physiologic responses to drugs and stress.

Physiology

Cardiovascular system

Geriatric patients have decreased cardiovascular reserve and diminished compensatory mechanisms compared with adult animals. In adults, hypotension triggers a baroreceptor reflex that increases heart rate and contractility, whereas in geriatric animals this reflex is reduced.[2,3] These patients are more reliant on adequate plasma volume for blood pressure maintenance, but renal free water excretion is less efficient, and the geriatric heart and lungs are more susceptible to congestive heart failure and pulmonary oedema.

Geriatric patients have decreased blood pressure under normal conditions, resulting in a higher resting heart rate and longer circulation time.[2,4,5] The latter causes a longer onset of effect for injectable drugs, which may lead to premature repeated and excessive drug administration. As the cardiac conduction system ages, it becomes more susceptible to arrhythmias, especially when the aging cardiopulmonary system fails to meet the increased myocardial oxygen demands associated with pain and stress.

Respiratory system

The aging lungs have decreased functional residual capacity - the reserve volume available for gas exchange during apnoea - and thus faster onset of hypoxemia. Decreased chest wall compliance means the work of breathing is increased, while the aging muscles fatigue more quickly.

These changes increase the risk of hypoventilation during anaesthesia. Hypercapnia causes acidosis and decreased cardiac contractility, which negatively affect blood pressure. Sometimes the patient will mount a sympathetic response to the hypercapnia, but this can be equally detrimental, with tachycardia increasing myocardial oxygen demand and vasoconstriction reducing renal and hepatic blood flow.

Renal and hepatic systems

Many geriatric animals have reduced renal mass, renal filtration, and excretion.[2] Similarly, they have reduced hepatic mass, which leads to a decrease in total hepatic enzymatic function and blood flow, causing

delayed drug clearance. Vasoconstriction which can occur in response to stress or pain reduces renal and hepatic blood flow, compromising renal perfusion and further reducing metabolic function. Of course, any disease of the kidneys and/or liver will further alter drug metabolism and clearance, exacerbate the hemodynamic consequences of anaesthesia, and predispose the patient to acute kidney injury.

Neurologic system

Geriatric patients require lower doses of anaesthetic drugs to produce the same clinical effect.[4] This phenomenon, combined with delayed onset due to longer circulation time, places these patients at a higher risk for overdose from repeated drug administration, resulting in excessive anaesthetic depth and prolonged recoveries.

Visual and hearing impairment, as well as cognitive dysfunction, are common in aging pets (Fig. 1). These conditions predispose patients to confusion and stress during hospitalisation, which is exacerbated by restraint. The sympathetic response to stress can be detrimental in these patients, as their vital organs lack the functional reserve to compensate for stress-related tachycardia, vasoconstriction, and increased oxygen demand.

Body composition

Some geriatric patients have excess fat and an increased volume of distribution for most anaesthetic drugs. This prolongs the duration of action but does not warrant an increased dose, as geriatric patients usually require a lower dose for a given clinical effect. Geriatric patients may alternately present with very little fat, which, in conjunction with reduced muscle mass, increases their risk for hypothermia (Fig. 2). Hypothermia impairs cardiovascular function, reduces anaesthetic drug requirements, prolongs recovery, and causes discomfort and shivering. Shivering exacerbates pain, stimulates catecholamine release, and increases oxygen demand.[6]

Between the decreased muscle mass and higher incidence of osteoarthritis, geriatric patients should be transported and positioned with care. Adequate padding of dependent areas and reducing stress on joints and ligaments are essential. When considering analgesic drugs, the pain associated with positioning should be considered in addition to the procedure itself.

Anaesthetic management

Preanesthetic assessment

The practitioner should complete a thorough history, including a review of comorbidities and medications. Diagnostic tests should be performed and reviewed ahead of time to screen for new comorbidities or determine the extent of known disease. These should include blood work especially packed cell volume/

Fig. 1 - A 14-year-old dog with cataracts and hearing impairment staying warm after recovery from anaesthesia for CT and rhinoscopy.

Fig. 2 - This 15-year-old dog has muscle wasting and no excess fat, increasing the risk of anaesthesia-induced hypothermia.

total solids, liver enzymes, blood urea nitrogen, creatinine, symmetric dimethylarginine, electrolytes (a thyroid panel, and clotting profile could be considered if indicated), urinalysis, and diagnostic imaging (chest x-rays, with or without abdominal ultrasound if indicated by abnormalities on physical exam or blood work). Abnormalities should be corrected prior to anaesthesia when possible; otherwise, referral to a specialty practice for further workup and preanesthetic optimization should be considered.

Most medications should be continued, with few exceptions.

- Angiotensin-converting enzyme (ACE) inhibitors (benazepril, enalapril) should be withheld the morning of anaesthesia to reduce the incidence of refractory hypotension.[7]
- Telmisartan, an angiotensin receptor blocker used increasingly for the treatment of protein-losing nephropathy, acts on the same pathway, and withholding this drug may be prudent.
- The antithrombotic medication clopidogrel should be discontinued 10 days prior to surgery but can be continued for nonsurgical procedures.
- Patients receiving prednisone for hypoadreno-corticism should receive an increased dose (ie, double their normal morning dose) to help them tolerate the stress associated with anaesthesia and surgery.
- Some medications can also alter the effects of sedative and anaesthetic drugs. For example, phenobarbital induces hepatic enzymes and can hasten drug clearance, but the clinical effect of sedative and anaesthetic drugs may be more pronounced.
- Patients receiving medications that affect vasomotor tone (ACE inhibitors, calcium channel blockers, pimobendan) are at a higher risk for hypotension from vasodilating agents, especially acepromazine and inhalant agents.

A drug reference should be consulted for a list of potential drug interactions.

Premedication

Premedication is the use of sedative and analgesic agents prior to the induction of anaesthesia. This practice reduces stress associated with restraint and anaesthesia, facilitates intravenous catheter placement, reduces the doses of anaesthetic drugs required, provides pre-emptive analgesia, and improves the quality of recovery. Combination protocols capitalise on drug synergism, allowing a reduced dose of each drug.

Onset and clinical effect can be unpredictable in geriatric patients, and the practitioner should be prepared to provide supplemental oxygen using a face mask upon onset of sedation.

The combination of an opioid appropriate for the level of pain anticipated and a benzodiazepine offers analgesia and mild sedation in geriatric patients with minimal cardiorespiratory effects. In very anxious or fearful patients for whom a benzodiazepine will offer inadequate sedation, a low dose of acepromazine (0.01-0.03 mg/kg) can be considered, weighing the benefits of superior sedation with the risk for hypotension.

Alpha-2 agonists (eg, dexmedetomidine) decrease cardiac output,[8] which is not desirable given the age-related changes in cardiovascular function and cardiac reserve. However, these drugs also reduce sympathetic tone and the detrimental effects associated with increased circulating catecholamines. Use of a conservative dose (0.5 - 2 ug/kg) in combination with an opioid and benzodiazepine may be useful in the stressed geriatric patient.

Ketamine at a moderate intramuscular dose of 1 to 2 mg/kg in dogs or 2 to 3 mg/kg in cats is a safe and effective alternative to dexmedetomidine when an opioid/benzodiazepine combination will not provide adequate sedation. Ketamine at moderate to high doses should be avoided in patients with pre-existing tachycardia, hypertension, or hypertrophic cardiomyopathy due to the potential for sympathetic stimulation and increased myocardial oxygen demand.

Alfaxalone can also be used for intramuscular sedation in geriatric cats and dogs at doses of 1 to 3 mg/kg, in combination with an opioid and benzodiazepine. This is especially useful in fearful geriatric cats for whom ketamine is contraindicated due to the presence of cardiac disease. The high volume required makes this most practical for small patients and may warrant two injections to reduce muscle trauma. The level of sedation is unpredictable, and the patient may require supplemental oxygen or even intubation depending on the effect.

Induction

Induction of anaesthesia should be achieved with injectable agents. Mask and chamber inductions may cause a life-threatening stress response, and the dose of inhalant required to induce anaesthesia causes significant cardiovascular depression. Furthermore, these techniques expose personnel to high levels of waste anaesthetic gases.

Propofol is commonly used in geriatric patients because it can be titrated slowly to effect and the duration is short due to rapid redistribution. Propofol is also the drug of choice for patients with reduced liver function, because metabolism is largely extrahepatic. However, propofol can cause significant cardiovascular (bradycardia, vasodilation, decreased contractility, hypotension) and respiratory (hypoventilation, apnoea) derangements. The total dose needed can be reduced by titrating at a rate of 1 mg/kg/min,[9] and by using a co-induction agent such as ketamine and/or a benzodiazepine.

Alfaxalone has a similar effect profile to propofol, but with better maintenance of cardiac output owing to preservation of the baroreceptor reflex,[10,11] although the extent to which this is true in geriatric patients remains to be elucidated. Alfaxalone should be titrated at a rate of 0.5 mg/kg/min[9] and may be combined with ketamine and/or a benzodiazepine.

Fig. 3 - An infraorbital block is performed in a geriatric cat prior to a nasal biopsy.

Fig. 4 - Pulse oximetry monitoring of a geriatric brachycephalic dog during recovery from anaesthesia.

Because etomidate has minimal cardiorespiratory effects, it is ideal for patients with significant cardiac or respiratory disease. Adverse effects include pain on injection, gagging, and haemolysis. Co-induction with midazolam and administration with intravenous fluids running can mitigate these effects. In dogs, I have found that intravenous lidocaine administered just before etomidate seems to reduce pain on injection.

Ketamine at doses required for anaesthesia induction (2-6 mg/kg intravenously) causes tachycardia and increased myocardial oxygen demand, and thus is not ideal as a primary induction agent in geriatric patients with decreased cardiac reserve. However, it can be considered for use as a co-induction agent at lower doses.

Maintenance

General anaesthesia can be maintained with a variety of drugs and drug combinations. Regardless of drug choice, anaesthetised patients should be intubated and receive oxygen supplementation, with ventilatory support as needed. An experienced veterinary nurse or doctor should monitor the patient using pulse oximetry, capnography, electrocardiography, blood pressure and temperature measurement, and hands-on assessment of anaesthetic depth (palpebral, jaw tone), mucous membrane colour and refill time, and pulse quality.

Inhalant anaesthetics (eg, isoflurane, sevoflurane) cause vasodilation, decreased cardiac contractility, and respiratory depression. Geriatric patients are particularly susceptible to the resulting hypotension, hypoventilation, and hypoxemia. Therefore, use of a multimodal anaesthetic protocol to reduce inhalant anaesthetic requirements is recommended.

A ketamine continuous-rate infusion (CRI) can be administered during anaesthesia to provide analgesia and reduce anaesthetic requirements without causing sympathetic stimulation. Adding 120 mg ketamine to 1 L of fluids and administering at a rate of 5 mL/kg/hour will provide a ketamine infusion of 10 mcg/kg/min. Other CRIs I use commonly to reduce anaesthetic requirements include fentanyl (5-20 mcg/kg/hour) and lidocaine (25-75 mcg/kg/min).

Local blocks are effective for reducing anaesthetic requirements, improving patient comfort in the postoperative period, and reducing systemic opioid use (Fig. 3). Local anaesthetics are the only drugs that completely block nociceptive transmission, and I consider locoregional anaesthesia to be an essential component of a multimodal approach to anaesthesia and analgesia.

For critical or sick geriatric patients, inhalant anaesthetics may not be well tolerated, and a total intravenous anaesthesia technique should be considered. A propofol CRI (0.1-0.4 mg/kg/min) can be used but tends to have similar cardiovascular and respiratory effects to inhalant anaesthetics. Alfaxalone at a rate of 0.05 to 0.2 mg/kg/min appears to have a more favourable cardiovascular effect profile. Use of other concurrent CRIs (fentanyl, ketamine,

About half of all anaesthesia-related deaths in dogs and cats occur during recovery, mostly during the first 3 hours.[12]

Dr. Kenneth Joubert advice - keep geriatric patients on oxygen as long as possible - until they are awake enough to breathe properly and ventilate deeply by themselves - Ed.

and/or lidocaine) can reduce the requirement for propofol or alfaxalone.

During anaesthesia, many geriatric patients require additional cardiovascular support. Judicious use of fluid therapy is recommended, and fluid boluses should be reserved for patients with evidence of hypovolemia (see box 1). Anticholinergics are often indicated to maintain heart rate in the normal range to optimise cardiac output and blood pressure. Ephedrine, dopamine, or dobutamine may be indicated for refractory hypotension, with the optimal choice depending on species and concurrent disease. Keep in mind that hypothermia may cause bradycardia and hypotension that are refractory to pharmacologic intervention.

Recovery

About half of all anaesthesia-related deaths in dogs and cats occur during recovery, mostly during the first 3 hours.[12] Compared with adults, geriatric animals are especially predisposed to prolonged recoveries due to slower drug clearance, more profound responses to anaesthetic drugs, and increased incidence of hypothermia, hypotension, and hypoxemia. Pulse oximetry, respiration, heart rate, blood pressure, and temperature should be monitored at regular intervals until these vitals return to within normal limits or near baseline (Fig. 4). Patients with visual or hearing impairment or cognitive dysfunction may become confused and agitated during recovery, and may require additional time to recover. In elderly humans, full return of cognitive function to preoperative levels after general anaesthesia may require up to 2 weeks.[3] In older laboratory animals given general anaesthesia, impairment of learning persists long after the effects of anaesthetic agents have dissipated.[3]

Conclusion

Geriatric dogs and cats are at an increased risk for anaesthesia-associated complications because of the normal physiologic changes that occur with aging. They are also more likely to present with concurrent diseases. Anaesthesia for these patients should be performed only after a thorough preanesthetic assessment and patient stabilization.

Reduction of stress and pain in the peri-anaesthetic period is essential to avoid excessive sympathetic stimulation. While no specific drug protocol has been shown to decrease morbidity or mortality in geriatric patients, the practitioner should use a multimodal approach and tailor anaesthetic protocols to each individual patient, taking into account aging changes and comorbidities.

Patients should be monitored closely from premedication to full recovery from anaesthesia, and the practitioner should be prepared to provide ventilatory and cardiovascular support beyond that which most healthy adult animals require. Advanced age is neither a disease nor a contraindication to anaesthesia but demands special care and attention from the practitioner to promote the best outcomes for these patients.

References

1. Egenvall A, Nødtvedt A, Häggström J, Ström-Holst B, Möller L, Bonnett BN. Mortality of life-insured Swedish cats during 1999-2006: age, breed, sex, and diagnostics. J Vet Intern Med. 2009;23(6):1175-1183. doi:10.1111/j.1939-1676.2009.0396.x
2. Hughes JML. Anaesthesia for the geriatric dog and cat. Ir Vet J. 2008;61(6):380-387. doi:10.1186/2046-0481-61-6-380
3. Muravchick S. Anesthesia for the geriatric patient. In: Barash PG, Cullen BF, Stoelting RK (eds). Clinical Anesthesia, 5th ed. Lippincott-Raven; 2005:531-540.
4. Kukanich B. Geriatric veterinary pharmacology. Vet Clin North Am Small Anim Pract. 2012;42(4):631-642. doi:10.1016/j.cvsm.2012.04.007
5. Meurs KM, Miller MW, Slater MR, Glaze K. Arterial blood pressure measurement in a population of healthy geriatric dogs. J Am Anim Hosp Assoc. 2000;36(6):497-500. doi:10.5326/15473317-36-6-497
6. Diaz M, Becker DE. Thermoregulation: physiological and clinical considerations during sedation and general anesthesia. Anesth Prog. 2010;57(1):25-33. doi:10.2344/0003-3006-57.1.25
7. Coleman AE, Shepard MK, Schmiedt CW, Hofmeister EH, Brown SA. Effects of orally administered enalapril on blood pressure and hemodynamic response to vasopressors during isoflurane anesthesia in healthy dogs. Vet Anaesth Analg. 2016;43(5)482-494. doi:10.1111/vaa.12338
8. Murrell JC, Hellebrekers LJ. Medetomidine and dexmedetomidine: a review of cardiovascular effects and antinociceptive properties in the dog. Vet Anaesth Analg. 2005;32(3):117-127. doi:10.1111/j.1467-2995.2005.00233.x
9. Bigby SE, Beths T, Bauquier S, Carter J. Effect of rate of administration of propofol or alfaxalone on induction dose requirements and occurrence of apnea in dogs. 2017;44(6):1267-1275. doi:10.1016/j.vaa.2017.03.005
10. Hampton CE, Riebold TW, LeBlanc NL, Scollan KF, Mandsager RE, Sisson DD. Effects of intravenous administration of tiletamine-zolazepam, alfaxalone, ketamine-diazepam, and propofol for induction of anesthesia on cardiorespiratory and metabolic variables in healthy dogs before and during anesthesia maintained with isoflurane. Am J Vet Res. 2019;80(1):33-44. doi:10.2460/ajvr.80.1.33
11. Muir W, Lerche P, Wiese A, Nelson L, Pasloske K, Whittem T. Cardiorespiratory and anesthetic effects of clinical and supraclinical doses of alfaxalone in dogs. Vet Anaesth Analg. 2008;35(6):451-462. doi:10.1111/j.1467-2995.2008.00406.x
12. Brodbelt DC, Blissit KJ, Hammond RA, *et al.* The risk of death: the confidential enquiry into perioperative small animal fatalities. Vet Anaesth Analg. 2008;35(5):365-373. doi:10.1111/j.1467-2995.2008.00397.x

Molly Allen, DVM, DACVAA, is an anesthesiologist at BluePearl Specialty + Emergency Pet Hospital in Waltham, Massachusetts. Her special interests include anesthesia training, patient safety, advanced locoregional techniques, and strategies for promoting enhanced recovery from anesthesia in small animal patients.

Upping your Lateral Suture Game

Jason Syrcle, DVM, DACVS

Lateral suture stabilization is a viable treatment option for cranial cruciate ligament injury in dogs. Here are key points for increasing success in these cases.

Lateral suture stabilization is a time-tested treatment for cranial cruciate ligament (CCL) rupture in dogs. Although tibial plateau leveling osteotomy (TPLO) and other osteotomy procedures are considered the gold-standard treatment for most patients, a lateral suture can also produce good results, especially with proper case selection. The lateral suture procedure is a more affordable option for owners and a less complex procedure that may be more accessible to general practitioner surgeons. However, a few critical steps are key to increasing the likelihood of success.

Stifle exploration

A thorough stifle exploration via arthrotomy or arthroscopy is crucial for the successful treatment of CCL rupture. Most surgeons treating with a lateral suture will opt for a lateral parapatellar approach. The CCL is evaluated first, confirming the diagnosis. In dogs with a complete CCL tear, debridement of the torn ligament will facilitate visualization of other intra-articular structures.

A partially torn CCL presents more of a challenge for meniscal evaluation. Leaving a partially intact CCL in place has been associated with better long-term joint health in dogs receiving TPLO, including improved cartilage scoring on second-look arthroscopy.[1] However, a thorough evaluation of the menisci is difficult when performing an arthrotomy in a joint with a partially intact CCL. I prefer to assess the remaining ligament as "competent" or "incompetent." Competent ligaments have substantial remaining structure, often with at least 50% of the original ligament intact.

A slender instrument such as a ball-end probe or a neuro hook is very useful for palpating the CCL as well as the menisci. Incompetent partial tears have fewer intact fibers, which may be stretched, allowing some cranial drawer movement. I debride incompetent partial tears to better assess the menisci but typically leave competent tears intact, with the assumption that significant meniscal injury is much less likely in those cases.

Meniscal treatment

Meniscal injury is quite common in dogs with CCL rupture. Dogs with meniscal tears tend to be more lame preoperatively and inadequate treatment of these tears will lead to an unsuccessful outcome, even if stifle stability is achieved. Additionally, late meniscal injury is a diagnostic differential for dogs with recurrent or persistent lameness after stifle stabilization surgery. Knowledge of normal meniscal anatomy and of meniscal injury patterns is critical to successful meniscal treatment. Although thorough assessment and probing of both menisci are warranted, a bucket-handle tear of the caudal horn of the medial meniscus is the most common injury. Proper access to the caudal horn of the medial meniscus is often not possible without either distracting the stifle or cranially displacing the proximal tibia. Here are 3 methods that I use:

1. Apply a Senn retractor to the infrapatellar fat pad, applying cranial traction on the proximal tibia to "pull it into drawer," allowing visualization of the caudal joint. This tends to work best in small patients with a large degree of stifle laxity (Fig. 1).

2. Use a thrust lever instrument to hook the caudal aspect of the proximal tibia while levering against the distal femur. This instrument can be a slender thrust lever (my preference), a mini Hohmann retractor, or a curved hemostat appropriately sized for the patient (Fig. 2).

3. Use a self-retaining retractor to distract the femur and tibia. This can be a standard Gelpi retractor (my preference) or specialized stifle distractor. Place the tips of the retractor in the fossa of the origin of the CCL proximally and in the cranial intermeniscal ligament distally. Then, open the retractor carefully, distracting the femur and the tibia. Gentle stifle extension will increase the amount of distraction and allow better visualization in some cases. Do not perform forceful extension or flexion of the stifle while the retractor is in place; serious injury could result. This technique is most helpful in medium- to large-breed dogs (Fig. 3).

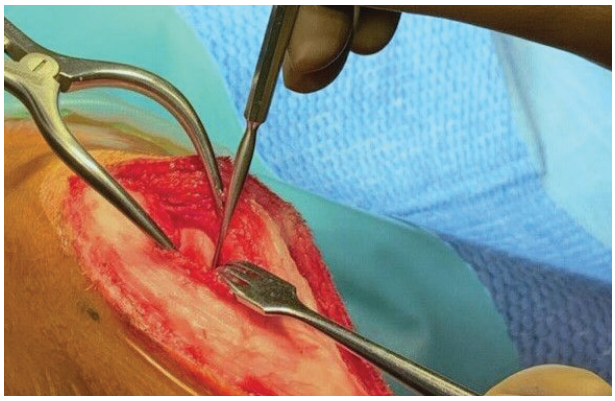


Fig. 1 - *Stifle arthrotomy with Gelpi retracting the patellar ligament, Senn retractor on the infrapatellar fat pad, and probe used to palpate intra-articular structures.*

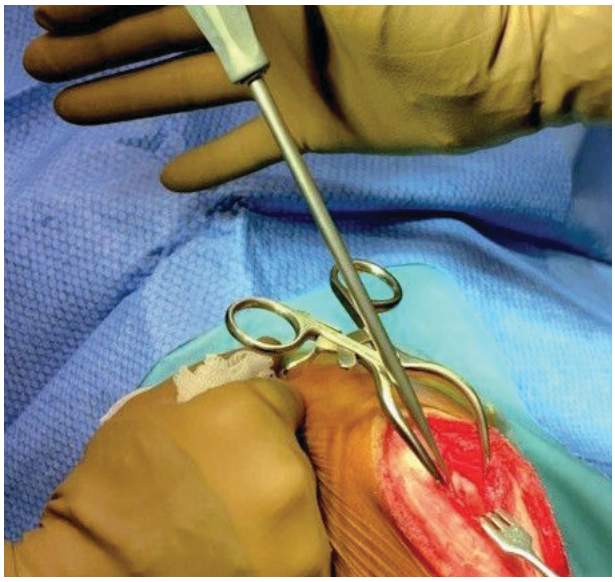


Fig. 2 - *Stifle arthrotomy with Gelpi retracting the patellar ligament. A thrust lever is inserted in the stifle, with the tip hooked caudal to the tibial plateau and the shaft of the instrument levering against the femoral condyles, causing cranial translation of the tibia.*

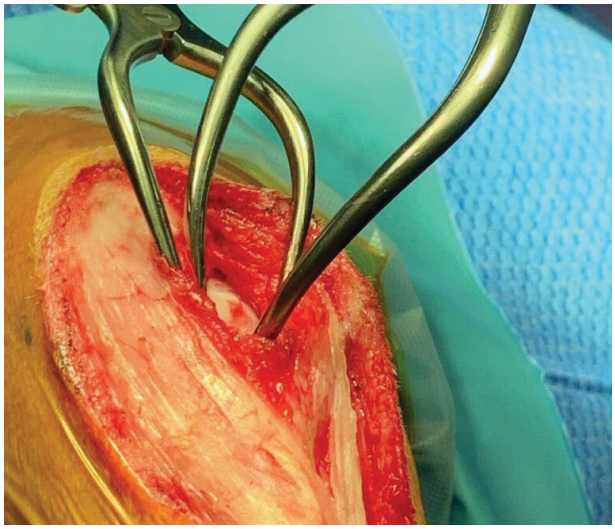


Fig. 3 - *Stifle arthrotomy with Gelpi retracting the patellar ligament. The larger Gelpi is being used as a stifle retractor, with the proximal tip in the cruciate fossa and the distal tip in the cranial intermeniscal ligament.*

Once the caudal joint is visualized, palpate the caudal meniscotibial ligament with a hook. Normal laxity of this ligament allows slight cranial translation of the caudal horn with traction, but significant translation (more than about 2-3 mm) suggests a meniscal tear, even if it is not immediately evident.

Treatment of a meniscal tear should completely remove the damaged portion of the meniscus but spare all uninjured meniscus. Complete medial meniscectomy is rarely indicated in these cases. Depending on the extent of injury, caudal horn meniscectomy or partial meniscectomy should be performed. Other than the instrument used for stifle distraction or tibial translation, required instruments include a probe (as described above), scalpel (#11, #15, or #64 blade), and mosquito haemostats. Kocher hemostats are preferred, if available, to provide a better grip on the torn meniscus.

Hook the meniscotibial ligament of the torn caudal portion of the meniscus with a probe and transect it. Once this transection is complete, the most axial part of the torn meniscus can be grasped with a haemostat and manipulated. Use the blade to excise the torn meniscus from the intact meniscus abaxially. Use the probe to palpate any remaining caudal meniscotibial ligament. Not uncommonly, multiple meniscal tears are present and must be treated. Once no further meniscal tissue is pulled cranially by traction on the meniscotibial ligament, or if the entire caudal pole of the meniscus has been removed, meniscal resection is complete.

Lateral suture stabilization

Many variations of the lateral suture procedure exist, but the most common involves the use of monofilament nylon leader line placed around the femoral-fabellar ligament, under the patellar tendon from lateral to medial, through a tibial tunnel from medial to lateral, and then tied or crimped laterally. If monofilament nylon leader line is chosen, be sure to select the appropriate suture size. This monofilament is rated in pounds, and this rating should correlate roughly to the bodyweight of the dog. For example, 40-lb test monofilament is typically selected for a 40-lb dog. Commonly available sizes are 20, 40, 60, 80, and 100 lb. When between sizes, I usually round up to the next heaviest suture. The leader line can be purchased with either a single or double strand with a swaged needle, which allows for easier suture passage. Alternatively, a length of sterile leader line is loaded onto an appropriate-sized cruciate needle.

Leader line can be tied or crimped. Crimps are commercially available for 40-, 80-, and 100-lb suture. When used with a ratcheting tension device, crimps allow greater control over suture tension. Crimped knots are also less likely to allow suture loosening over time and are less bulky.[2] If crimps are not available or if

hand-knotting is elected, strategies for tensioning the knot include using a sliding half-hitch (my preference) or a square knot with an assistant to clamp the first throw to hold tension while the second throw is placed.

Once an intra-articular assessment is complete, lavage the joint and close the joint capsule. The lateral retinacular fascia is not closed at this time and must be dissected free of the joint capsule to allow adequate exposure of the lateral fabella. Typically, a double strand of leader line is passed, either with a length of line loaded through a cruciate needle with equal resultant strands or with a swaged needle with double strands. Place the suture from proximal to distal around the femoral-fabellar ligament, axial to the fabella, and adjacent to the femur. Pass the suture as deeply as possible; tension on the suture should meet strong resistance and move the fabella.

Next, pass the suture from lateral to medial deep to the patellar ligament, in the region of the infrapatellar fat pad. In this region, the suture will not be intra-articular. A bone tunnel is created in the proximal tibia. The position of this bone tunnel is key to the success of the procedure; it should be placed relatively caudally and proximally. Create the bone tunnel with a pin and Jacobs chuck, or a drill bit just large enough to allow passage of 2 strands of suture. Elevate the cranial tibial muscle and retract it caudally. Pass the pin or drill bit from lateral to medial, just cranial to the long digital extensor tendon, and 5 to 10 mm distal to the joint. Cut the needle from the suture and guide the sutures from medial to lateral through the bone tunnel using a large hypodermic needle (16-18 gauge). Tie or crimp each suture so they have similar tension. Proper suture tension should eliminate cranial drawer but still allow normal stifle range of motion. Finally, perform routine closure of retinacular fascia, subcutaneous tissues, and skin.

Success with lateral suture stabilization is possible with excellent meniscal visualization and treatment, a well-placed tibial bone tunnel, and secure suture knots or crimps. Having a few relatively inexpensive instruments helps the surgeon perform these key steps successfully and efficiently.

References

1. Hulse D, Beale B, Kerwin S. Second look arthroscopic findings after tibial plateau leveling osteotomy. *Vet Surg*. 2010;39(3):350-354. doi:10.1111/j.1532-950X.2010.00676.x
2. Anderson CC III, Tomlinson JL, Daly WR, Carson WL, Payne JT, Wagner-Mann CC. Biomechanical evaluation of a crimp clamp system for loop fixation of monofilament nylon leader material used for stabilization of the canine stifle joint. *Vet Surg*. 1998;27(6):533-539. doi:10.1111/j.1532-950x.1998.tb00528.x

Jason Syrcle, DVM, DACVS-SA, is associate professor of clinical small animal orthopedic surgery in the Department of Clinical Sciences & Advanced Medicine, and chief of Small Animal Surgery at the Matthew J. Ryan Veterinary Hospital at the University of Pennsylvania School of Veterinary Medicine in Philadelphia.

Imaging of Nasal Disease

Dr Nicolette Hayward BVM&S DVR DipECVDI MRCVS

Introduction

Nasal disease and paranasal sinus disease are relatively common conditions in cats and dogs, and definitive diagnosis of the causative pathology can be challenging. Rhinoscopy, nasal flushes, biopsies, and serology are all valuable diagnostic tools. However, frequently a multi-modality approach may be required where results are inconclusive. The primary aims of imaging nasal and sinus disease are to determine the extent of pathology, create an ordered differential list of likely aetiology, and to aid planning for further investigations or therapy.

Historically, radiography has been the standard imaging technique for the diagnosis of nasal disease, and remains the principal first imaging resource used in general practice.

Radiographic examination provides a non-invasive, and frequently effective method of diagnosing nasal pathology (e.g. >80% of nasal tumours) at relatively low cost. However, radiographic findings may prove vague or non-specific, as well as offering only two-dimensional information.

In recent years, three-dimensional imaging modalities have become more widespread in veterinary practice, and may provide valuable information where radiography has proven inconclusive. Furthermore, the multi-planar approach that CT and MRI offer enable full characterisation of pathology to be established for surgical planning, radiotherapy, and prognostic purposes. The choice of which advanced imaging modality is used frequently depends upon its availability, as well as cost issues.

Indications

- Nasal discharge
- Epistaxis
- Sneezing
- Head trauma
- Swelling
- Pain
- Proptosis
- Epiphora

Radiography

To obtain accurate patient positioning, general anaesthesia is usually required, unless the patient is very depressed. At least four projections are recommended for a complete study.

Projections

- Lateral
  - Overview of nasal chambers, frontal sinuses, skull and pharynx
  - Superimposition of bilateral structures

Table 1: Comparison of imaging modalities

	Advantages	Disadvantages
Radiography	• Cheap • Available • Frequently diagnostic	• May be inconclusive • No differentiation soft tissue and fluid
CT	• Multi-planar • Good bone detail • Some fluid/soft tissue differentiation (<MRI) • Fast	• Expensive • Limited availability • Expertise required
MRI	• Multi-planar • Good soft tissue contrast • Excellent soft tissue and fluid differentiation • Valuable where brain or orbit involved	• Expensive • Limited availability • Expertise required • Time consuming

- Dorso-ventral or ventro-dorsal
  - Superimposition of mandible over nasal chambers
  - Remove ET tube for evaluation of midline structures
- Dorso-ventral intra-oral
  - Good for nasal chambers
  - No superimposition of mandibles
  - Enables evaluation of symmetry
  - Most informative projection
- Lesion-oriented oblique
  - May be useful where standard orthogonal views are inconclusive
- Rostro-caudal skyline
  - Highlights frontal sinuses and cranium (Fig. 1)
  - Patient in dorsal recumbency with hard palate vertical
- Caudo-rostral horizontal beam
  - Highlights frontal sinuses
  - Care with radiation safety
- Ventral 20° rostral - dorso-caudal oblique
  - Useful where intra-oral view fails to reach caudal extent of nasal cavity e.g. where thin film carrier is not available
  - Patient in dorsal recumbency with maxilla parallel to cassette with mouth held open with ties, tube head tilted into mid nasal cavity

Computed Tomography

CT offers exquisite bony detail and has been shown to be more accurate and sensitive than radiography for the investigation of nasal disease in many studies (>90% sensitivity). In some cases, CT is also more accurate than biopsy or rhinoscopy in reaching a diagnosis. Post-contrast studies should be included. Where symptoms such as neurological signs, exophthlamos and nasopharygeal pathology suggest that the cranium and nasal chambers have been breached, CT or MRI are indicated.

Magnetic Resonance Imaging

MRI offers the most information for nasal and sinus disease due to its good soft tissue contrast, which enables the differentiation of fluid from soft tissues, unlike radiography. As such, radiography tends to over-estimate tumour size. An MRI study should include sequences in all three planes and a postcontrast study to evaluate potential intracranial extension of pathology. MRI is particularly useful for differentiating tissue and fluid within the frontal sinuses and tympanic bullae.

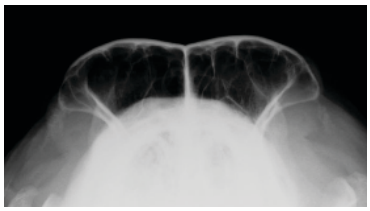


Fig 1 - Radiographic rostro-caudal skyline projection for frontal sinuses

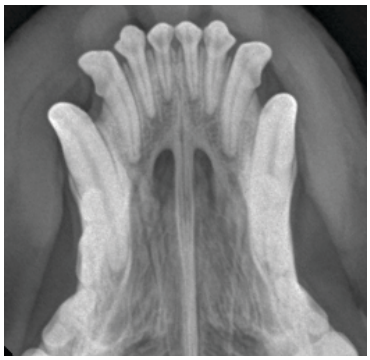


Fig. 2 - Dorso-ventral intra-oral projection of canine maxilla

Normal Anatomy

Skull shape and size varies widely with breed types, but can largely be categorised as follows:

- Dolichocephalic (long nosed)
- Mesaticephalic (equal cranium and nose length)
- Brachycephalic (short nosed)

Turbinate detail, as seen in Fig. 2, should be clearly delineated and generally symmetrical, although may be less so in brachycephalic dogs and cats.
The rostral third of the nasal chamber contains a fine linear distribution of turbinates.

The middle third has a more honeycomb appearance.

The caudal third of the nasal chamber has a larger linear pattern.

Approach

Acute onset nasal signs are often unrewarding to image unless traumatic, but radiography provides a high diagnostic yield where chronic disease is present.

Accurate positioning to minimise rotation is vital in order to assess symmetry.

Evaluation of the nasal chambers requires assessment of the following criteria:

- Symmetry and integrity of turbinates and nasal meati (intra-oral views)

- Alteration in radiographic opacity
  - Mass effect
    - Soft tissue
    - Bone
  - Increased lucency indicative of turbinate destruction
  - Loss of integrity of cortical bone
  - Trapped fluid in nasal chambers or sinuses
- Assessment of nasal septum / vomer bone
  - Integrity
  - Deviation
- Presence of pathology unilaterally or bilaterally
- Extent of pathology including involvement of sinuses and orbits
- Patency of nasopharynx
- Dental changes

Pathology

Where chronic nasal disease is present in dogs, radiographic changes can usually be categorised into non-destructive/non-neoplastic disease, destructive/non-neoplastic disease, or neoplastic disease. The severity of changes generally reflects the severity and chronicity of signs, but normal nasal radiographs do not rule out nasal disease.

Acute Rhinitis

In the acute stages, there may be only minor mucosal swelling and discharge, and radiographically the nasal chambers commonly appear normal. A subtle 'unsharpness' of turbinate detail may be identified in some cases.

Chronic Rhinitis

As the condition progresses, chronic rhinitis typically presents with a diffuse or patchy increase in soft tissue opacity over one or, more commonly, both nasal chambers (Fig. 3). Whilst turbinate detail may be reduced in clarity, it remains largely intact. MRI may show mucosal thickening and variable accumulation of fluid in the meati and sinuses (Fig. 4)

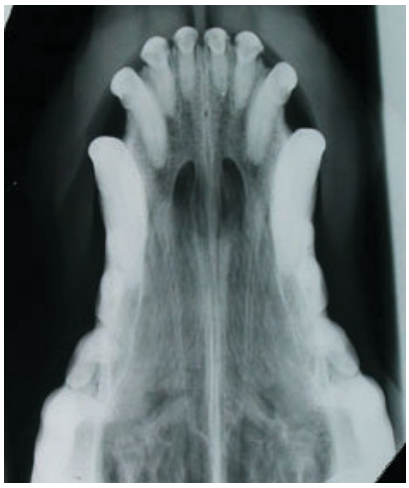


Fig. 3 (top) - Dorso-ventral intra-oral radiograph showing subtle increase in soft tissue opacity in both nasal chambers but no turbinate or bony destruction.

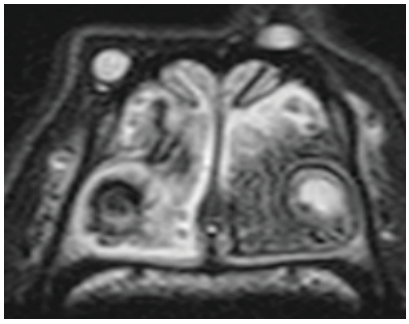


Fig. 4 (bottom) - MRI transverse plane T2W image, right is to the left of the image. There is diffuse hyperintense (white) signal intensity throughout the right nasal chamber and dorsal left chamber, indicative of mucosal thickening and discharge. No turbinate or bony destruction is evident.

Destructive Rhinitis

Destructive rhinitis is most commonly associated with fungal infection in the dog, and radiographically presents as variably sized lucencies within one or both nasal chambers (Fig. 5). Deviation of the nasal septum / vomer is rare compared to neoplasia.

There may be localised areas of soft tissue opacity, corresponding to accumulation of secretions and/or fungal plaques, which may also extend into the frontal sinuses. In severe cases, there may be punctate

Table 2: Summary of radiographic findings with chronic nasal disease in dogs

Lesion	Nasal tumour	Destructive rhinitis	Non-destructive disease
Turbinate destruction	Common	Common	Mild / none
Opacity	Increased	Variable / patchy	Normal / mild
Deviation of/changes of integrity to the Vomer / Septum	Common	Rare	None
Distribution	Unilateral or bilateral	Commonly bilateral	Commonly bilateral unless foreign body
Skull involvement	Common	Pinpoint lucencies	None

lucencies within the cortical bone of the maxillae and frontal bones. Both MRI and CT demonstrate the severity and extent of turbinate loss, and are particularly useful where early disease is present. (Fig. 6, Fig. 7).

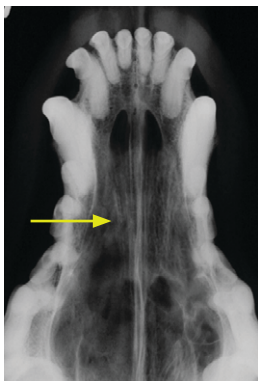


Fig. 5 - Radiographic dorso-ventral intra-oral projection of a dog with destructive rhinitis.There is loss of turbinate detail in right caudal nasal chambers, arrowed.

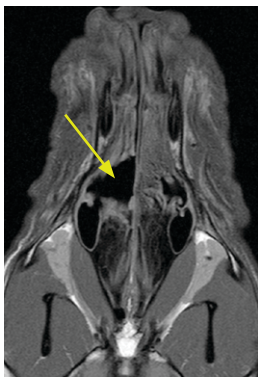


Fig. 6: MRI T1W dorsal plane image of destructive rhinitis in a dog. A large defect is clearly evident in the caudal aspect of the right nasal chamber with loss of turbinate detail, arrowed.

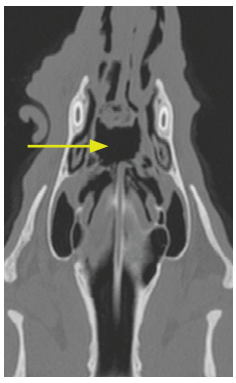


Fig. 7 - CT dorsal plane reconstruction showing destructive rhinitis in a dog with a large defect in turbinate detail, arrowed.

Rhinitis in Cats

There is often a natural asymmetry between the nasal chambers of the cat, also with deviation of the nasal septum, and therefore this anatomical variation should be considered when interpreting radiographs of the feline nose. Infections such as Calicivirus, Herpes virus, Bordetella, Chlamydia and Cryptococcus, and FIV may produce chronic inflammatory and potentially structural changes in the nasal mucosa, which are shown best by MRI (Fig. 8).

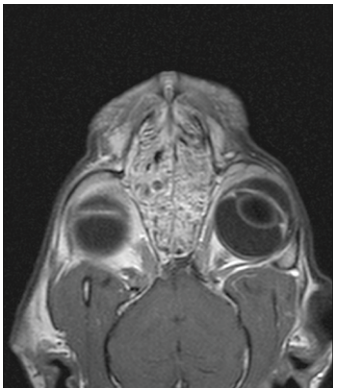


Fig. 8 - MRI dorsal plane T1W image of a cat with chronic rhinitis. There is bilateral thickening of the nasal mucosa and reduced air lucencies within the nasal turbinates, bilaterally. The nasal septum deviation is likely to represent normal anatomical variation.

Radiographically, these changes would typically appear as for chronic rhinitis in the dog, although occasionally may demonstrate more lytic changes. Fluid accumulation is not uncommon in the frontal sinuses.

Foreign Body Rhinitis

Most commonly caused by grass seeds and other plant fragments, these objects are not seen radiographically per se. However, when chronic, the local inflammation they induce may be seen as a local thickening of soft tissue and loss of turbinate definition, normally in one nasal chamber. Radiopaque foreign bodies such as needles or gunshot are readily identified and well localised on orthogonal radiographic projections. MRI and CT are valuable for assessing the three-dimensional effect of foreign material within the nose (Fig. 9). MRI in particular may indirectly highlight this material by demonstrating local inflammatory changes and fluid accumulation, even where visualisation of the foreign body itself is not possible.

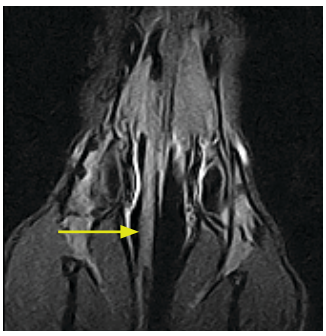


Fig. 9 - Dorsal plane T1W MRI image of a dog, right is to the left of the image. There is a foreign body (stick) in the right nasal chamber, arrowed.

Neoplasia

Primary nasal neoplasia in the dog and cat is rare, but frequently malignant, and the commonest cause of chronic nasal discharge in dogs. Differential diagnoses include adenocarcinoma, squamous cell carcinoma, chondrosarcoma, osteosarcoma and lymphoma.

Radiographically, neoplasia is typically identified as a soft tissue mass lesion, obliterating local turbinate detail unilaterally or bilaterally (Fig. 10). As the mass grows, it may obstruct drainage of secretions, resulting in accumulation of fluid caudal to the mass, for example in the frontal sinuses. Amorphous mineralisation is occasionally seen within nasal tumours.

Advanced tumours may cause thinning, deviation or destruction of the vomer bone and overlying incisor, nasal or maxillary bones. A mass may also cause destruction of the hard palate, seen as an area of lysis, which may be confused with destructive rhinitis, despite the primary radiographic sign of a solid increase in opacity within the nasal chamber.

In patients where differentiation between rhinitis and nasal neoplasia remains unclear, CT and MRI offer

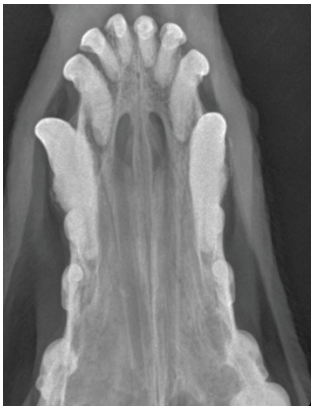


Fig. 10 - Dorso-ventral intra-oral radiograph of a dog, right is to the left of the image. There is a right sided nasal neoplasm, associated with opacification of the right nasal chambers, with loss of turbinate detail and thinning of the vomer bone.

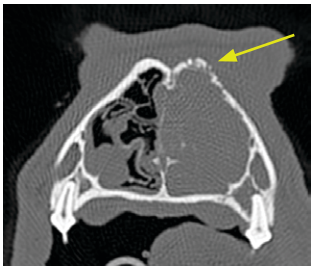
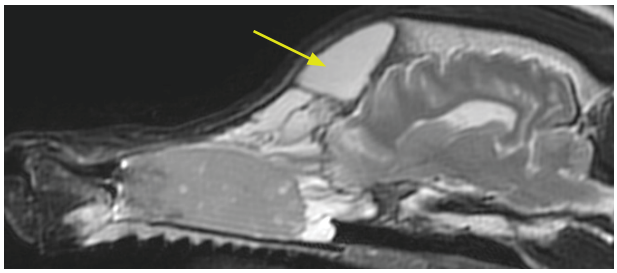


Fig 11: Transverse CT image, right is to the left of the image. There is a soft tissue mass replacing the turbinates within the left nasal chamber, with lysis of the overlying maxilla, arrowed.



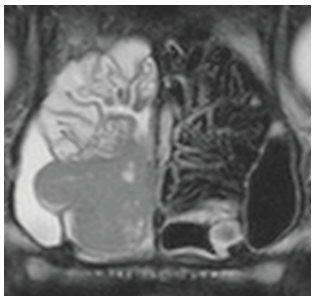


Fig. 12 - MRI T2W transverse (left) and sagittal plane (right) images of a large right-sided nasal mass with extensive fluid accumulation as a result of obstruction of the frontal sinuses (white on T2W, arrowed).

three-dimensional evaluation of the pathological features and extent of the disease. Hence, local invasion into the contralateral nasal chamber, maxillary and frontal bones and sinuses, hard palate, orbits and even the cribriform plate may be assessed. Whilst CT offers exquisite bony detail, the soft tissue/fluid contrast that MRI provides is equally advantageous, and thus choice of advanced imaging used may be based on availability of either modality to the practice. (Fig. 11 and Fig. 12).

Trauma

Fractures of the nasal and maxillary bones frequently involve multiple fragments, as well as soft tissue swelling. Standard orthogonal radiographic projections may be supplemented by skyline and lesion-oriented oblique views (Fig. 13) to characterise the pathology. CT is particularly useful for establishing the three-dimensional effect of any bony displacement for surgical planning.

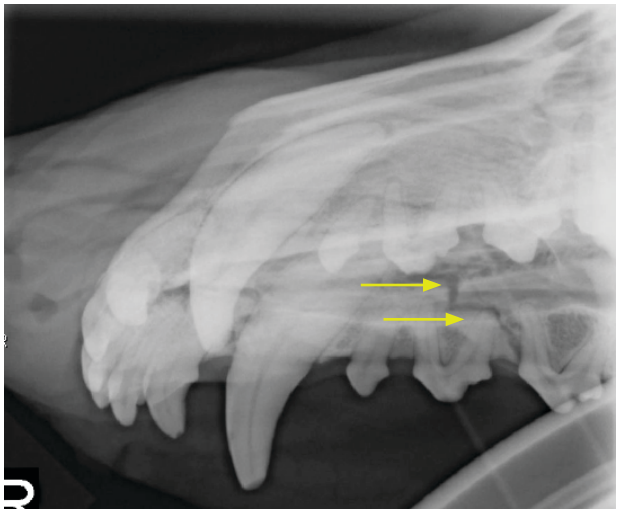
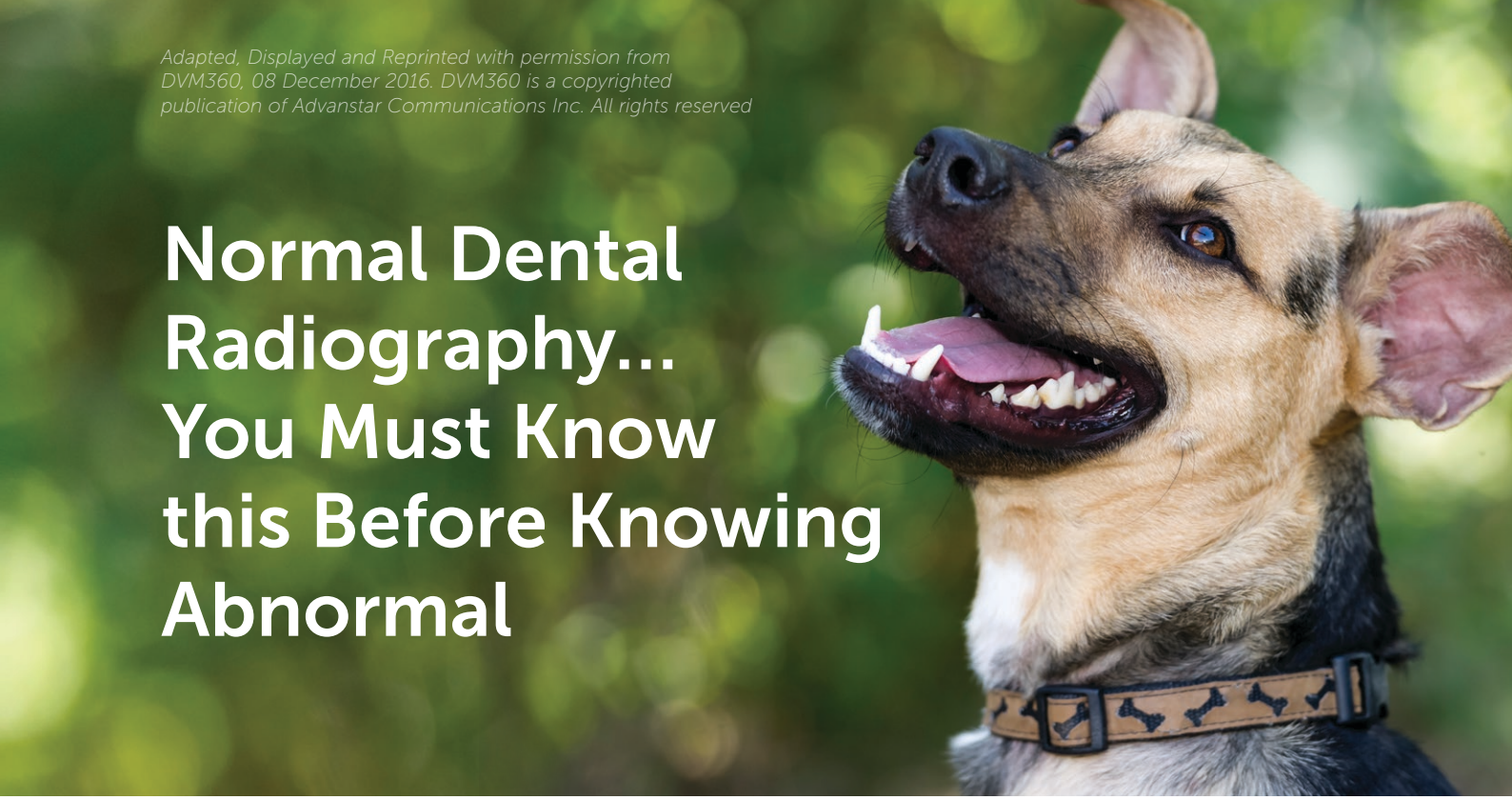


Fig. 13: Lesion orientated oblique radiograph (sagittal oblique view) highlighting an irregular radiolucent line consistent with maxillary fracture caudal to UPM3, arrowed.



Normal Dental Radiography... You Must Know this Before Knowing Abnormal

Barden Greenfield, DVM, DAVDC
MidSouth Veterinary Dental Referrals
Cordova, TN

Congratulations on the addition of dental radiography to your dental services! Without it, you are basically going to the moon without a navigation system, as almost 100% of all dental work requires radiography to assess the visible tooth and the underlying root structures. Utilization of conventional radiography falls considerably short in diagnostics and is truly wasting client's money.

Types of radiology generators and sensors

For those still considering dental radiography for their practice, there are two radiographic generator options. Wall mounted/floor units provide the DVM the ability to retake less than perfect radiographs by adjusting the tube head direction or distance. That tube head isn't moving unless you move it yourself. This is unlike the hand held dental radiography generators that are quite useful in tight quarters, providing your state allows these systems to be used. A disadvantage to this system is the tube head placement is hard to reproduce or adjust, but many overcome this issue quite easily.

Most systems have set kVp and milllamperage (mA) values, while others allow the operator to select mA between 7-15 mA and kVP between 60-90 kVp. Remember from radiography that the higher the kVp and lower mA makes fewer X-rays with higher penetration. Low kVp and high mA produces images using more x-rays but with less penetrating ability. Exposure time may be in fractions of seconds as with digital systems or pulses. A pulse is 1/60th of a second.

Conventional film used to be the gold standard of dental radiography. However, digital radiography affords the DVM images that are easily manipulated, catalogued, and visualized, and in many instances, superior to film. There is direct digital (computer generated) or indirect digital (utilization of phosphor plate to transfer image to computer). Size 2 direct digital sensors are available. Indirect digital utilizes size 1, 2, 3, 4 and even 6 sensor plates.

A good textbook reference is essential with dental radiography. One of the latest texts is by Gregg DuPont and Linda DeBowes (Atlas of Dental Radiography in Dogs and Cats; Saunders, 2009) and is an excellent reference. Other references are: Atlas of Canine and Feline Dental Radiography. Mulligan, TW, et al. Veterinary Learning Systems; 1998. An Atlas of Veterinary Dental Radiology. DeForge, DH; Colmery, BH. Iowa State Press; 2000.

Tooth root maturation

A recent study evaluated apical closure of mandibular 1st molar teeth (10 months) and canine (7 months) in the cats. Canine teeth apical closure is approximately the same. This is important to know with regard to

tooth fractures of young dogs and cats concerning which endodontic therapy to choose. It is also important with regard to orthodontic movement. Orthodontic movement is easier with an immature tooth than with a mature tooth (sound familiar?).

Pulp continues to mature throughout the life of a pet. Therefore, narrow dentin walls/wider pulp cavities are younger pets. As the tooth ages, the dentin wall gets thicker and the pulp canal gets narrower. One way to assess the vitality of a tooth is to radiograph the contralateral tooth to assess pulp cavity width. Premature maturation (tooth death) results in a static pulp canal width.

Q: What is the earliest age you can you radiographically identify adult precursers? 8-12 weeks

Radiographic positioning

Standardise your positioning and viewing of radiographs:

- Maxillary radiographs are positioned with the crowns facing DOWN. Mandibular views have crowns facing UPWARDS.
- View images as you are looking at the patient face-on.
- Right maxillary views have molars to the left and the canine to the right as you are viewing.
- For left maxillary, molars on the right and canines to the left.
- Mandibular views are the same (right arch has molars to left and canine to the right and left arch has molars to right and canines to the left).

Digital software packages have templates to allow images to be placed in their normal position. If you take an image and the template is set for a different quadrant, the image may be inverted or backwards, this telling you your image is in the wrong quadrant. (pretty cool!)

Maxillary 4th Premolar Teeth...how do I know which tooth root is the mesiobuccal and which is the mesiopalatal? There is a phrase, "Same Lingual, Opposite Buccal" or the SLOB rule that may be a bit confusing to some. What is a bit more understandable is this: The PALATAL ROOT of the 4th PREMOLAR is closest to the tube head (either from the mesial direction to the distal direction; or the distal direction to the mesial direction). Therefore, if you are taking an image of the caudal maxilla and the tube is facing slightly distally, the most forward (mesial) root is the mesiopalatal root. If your tubehead is slightly facing mesial (towards to nose), then when looking at the two mesial roots, the mesiopalatal root is the one closest to the tube head direction.

For maxillary and mandibular canine teeth, a rostral oblique radiograph provides the best view for potential vertical bone loss. An occlusal view or lateral view may not show bone loss due to the superimposition of the tooth over the alveolar bone.

Nomenclature to understand and use

This section will review common radiographic terms that are essential in understanding whether a patient has normal or abnormal radiographic pathology.

Here are some terms one may not be as familiar with:

- Mesial, Distal, Apical, Coronal
- Dentin, Pulp chamber
- Cementoenamel junction

- Periodontal ligament space
- Lamina dura
- Interradicular space
- Alveolar margin (marginal bone)
- Furcation
- Mandibular canal
- Palatine fissures
- Mandibular symphysis

Anomalies

- Chevron effect
- 3-rooted maxillary premolars (2nd and 3rd) and 2nd molars
- Gemination tooth
- Fusion tooth
- Curved root tips
- Microdontia
- Fusion
- Supernumerary teeth
- Twinning
- Missing teeth

Cats are different!

A study was performed evaluating the variations in the dentition of the domestic cat.
The following was noted from this study[4]:

- Maxillary 2nd premolar absent 7.9%; single rooted 27%; partly fused 55%; 2 fully formed roots 9%
- Maxillary 1st molar absent 2%; single rooted 35%; partly fused 34%, and 2 rooted 28%
- Maxillary 3rd premolar had supernumary roots in 10% of cases

Radiographic technical errors

Foreshortening and elongation are two common errors that can give the interpreter difficulty in adequately interpreting images. This is especially true with addressing endodontic disease, as foreshortened images make visualization of the apices more difficult.

Over and underexposing images are also quite common for the novice dental radiographer. Many times, increased contrast can be more appealing to the eyes, but at a cost. Septal bone may not be visualized with high contrast, therefore, a lower contrast which may be a bit less clear is preferred in many instances.

Overlapping roots is very common in the caudal maxilla, especially the distal root of the maxillary 4th premolar tooth overlapping the maxillary 1st molar. This non-diagnostic view needs to be modified by adjusting the tube head positioning (previously discussed). However, the two mesial roots of the 4th premolar tooth (mesiobuccal and mesiopalatal roots) may be visualized well, so keeping this image in the template may be worth while. But a disto-mesial tube head angulation must be used to adequately visualize the distal root of the 4th premolar tooth.

In brachycephalics, this can be very difficult, if not impossible due to rotated and crowded teeth. Probing should compliment this closely as sometime radiographic pathology may not be as prominent due to this process.

VETERINARY MEDICINE

CYTOPOINT
lokivetmab

the turning point!

LET'S GET TO THE POINT.

CYTOPOINT helps improve the quality of life for dogs and their families

Surveys of owners whose dogs have been treated with CYTOPOINT reflect that its **effective, convenient, long-term itch relief has a positive effect on quality of life!**

88% Say **they would recommend CYTOPOINT** to a friend whose dog has atopic dermatitis[1]

88% Say **their dog's quality of life has improved** since beginning treatment with CYTOPOINT[1]

88% Say **their own quality of life has improved** since their dog began receiving CYTOPOINT[1]

Indication

CYTOPOINT aids in the reduction of clinical signs associated with atopic dermatitis in dogs.

Repeat administration every 4 weeks as needed in the individual patient.

Reference:
1. Data on file. Pet Owner Submissions, August 2016. Zoetis LLC.

S4 **Cytopoint 10 mg** (Injection). Reg. No.: 17/24.5/15. Each vial of 1 ml contains 10 mg lokivetmab. S4 **Cytopoint 20 mg** (Injection). Reg. No.: 17/24.5/16. Each vial of 1 ml contains 20 mg lokivetmab.
S4 **Cytopoint 30 mg** (Injection). Reg. No.: 17/24.5/17. Each vial of 1 ml contains 30 mg lokivetmab. S4 **Cytopoint 40 mg** (Injection). Reg. No.: 17/24.5/18. Each vial of 1 ml contains 40 mg lokivetmab.
Cytopoint is a registered trademark of Zoetis.

For full prescribing information refer to the package insert approved by the medicines regulatory authority.
Full product information available from Zoetis South Africa (Pty) Ltd., Co. Reg. No.: 2012/001825/07, 6th Floor, North Wing, 90 Rivonia Road, Sandton, 2196. PostNet Suite 53, Private Bag 9976, Sandton, 2146, South Africa. Tel.: +27 11 245 3300 or 0860 ZOETIS (0860 963847). www.zoetis.co.za.
CA/LP/02/21/04

zoetis

The First Monoclonal Antibody Therapy for Canine Atopic Dermatitis

Cytopoint (lokivetmab) is a monoclonal antibody (mAb) that mimics the dog's natural immune function by specifically targeting and neutralising IL-31, an important cytokine involved in sending the itch signal to the brain in atopic dermatitis.[2]

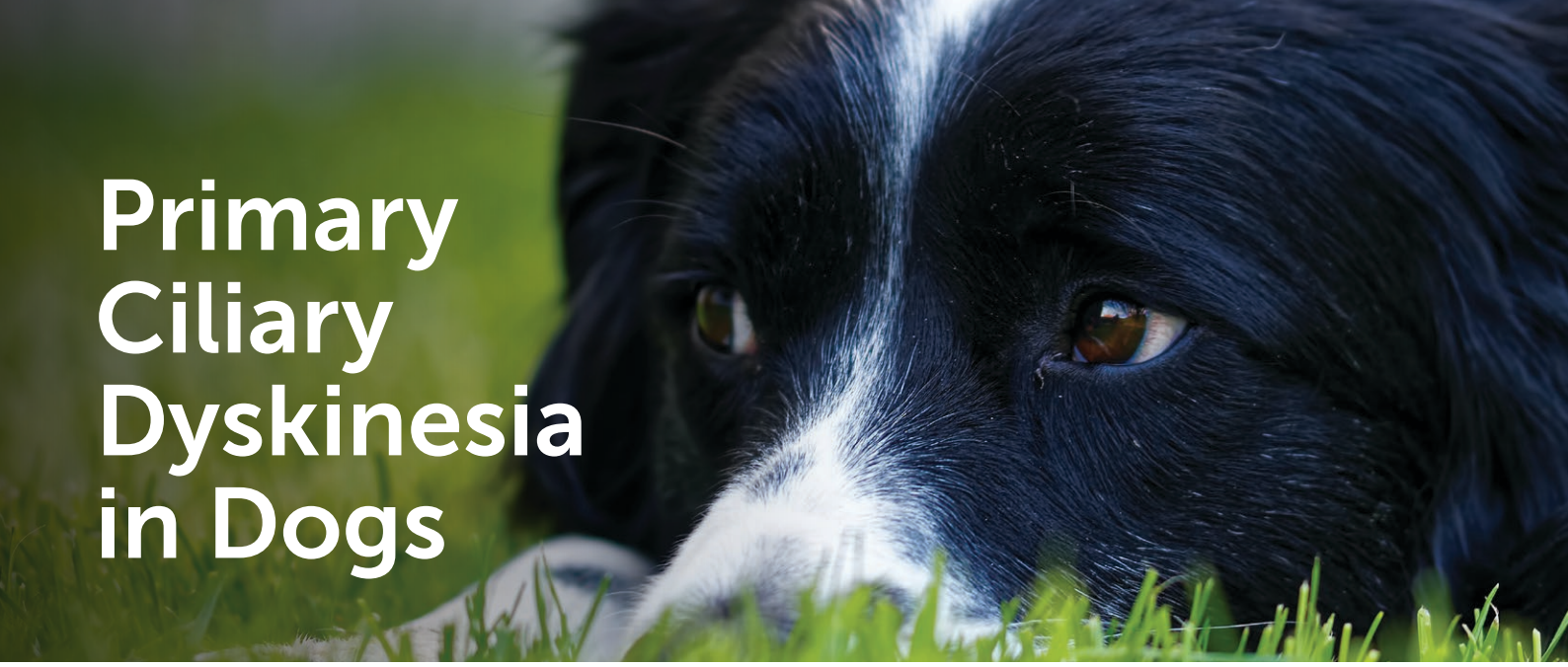
Because it is highly targeted to a specific cytokine involved in canine atopic dermatitis, lokivetmab has minimal impact on normal immune functions. It functions like naturally occurring antibodies and is eliminated through the process of catabolism, in the same way as normal protein degradation pathways, with minimal involvement of the liver and kidneys.

CYTOPOINT®

- Cytopoint (lokivetmab) is a caninized monoclonal antibody (mAb), that neutralizes the cytokine, interleukin (IL)-31.
- Indicated for atopic dermatitis in dogs.
- Dosage: 1 mg/kg bodyweight, single monthly subcutaneous injection.
- Rapid onset of efficacy – within 12-24 hours and lasts for 4 weeks.[1]
- Can be used in dogs of any age weighing 3 kg and over in bodyweight.
- Cytopoint has not been tested in pregnant, lactating, or breeding animals.
- Interrupts the itch cycle, allowing dogs to stop scratching so damaged skin can heal.[2]
- Delivers fast and sustained relief from pruritus.[3]
- Delivers continued improvement in skin lesions.[3]
- No restrictions with concomitant diseases.[4]
- No known drug interactions—minimal side effects in combination with commonly used medications, including[1,3]
  - APOQUEL (oclacitinib tablet), corticosteroids, cyclosporine and antihistamines.
  - Treatments such as endo- and ectoparasiticides, antimicrobials, anti-inflammatories and vaccines.
- Vaccines may be given on the day of treatment[1]
  - Any vaccine given at the same time as CYTOPOINT should be administered at a different injection site.
- Targeted mechanism of action may help minimize side effects and avoid unwanted effects on immune function.[2]
- Does not burden the liver or kidneys.
- No age restrictions.

References:

1. CYTOPOINT Summary of Product Characteristics.
2. Gonzales AJ, Humphrey WR, Messamore JE, *et al.* Interleukin-31: its role in canine pruritus and naturally occurring canine atopic dermatitis. *Vet Dermatol*. 2013; 24(1): 48–53. doi:10.1111/j.1365-3164.2012.01098.x.
3. Moyaert, H. , Van Brussel, L. , Borowski, S., Escalada, M. , Mahabir, S. P., Walters, R. R. and Stegemann, M. R. (2017), A blinded, randomized clinical trial evaluating the efficacy and safety of lokivetmab compared to ciclosporin in client owned dogs with atopic dermatitis. *Vet Dermatol*, 28: 593-e145. doi:10.1111/vde.12478.
4. Michels GM, Walsh KF, Kryda KA, *et al.* A blinded, randomized, placebo-controlled trial of the safety of lokivetmab (ZTS-00103289), a caninized anti-canine IL-31 monoclonal antibody in client-owned dogs with atopic dermatitis. *Vet Dermatol*. 2016; 27(6): 505–e136. doi:10.1111/vde.12364.



Primary Ciliary Dyskinesia in Dogs

Unistel Pets

Primary ciliary dyskinesia (PCD) is a recessive genetic disorder characterised by defective ciliary functioning within the respiratory and other systems (e.g. urogenital tract, auditory canal). In canines, symptoms typically appear in puppies 8 weeks and younger, and include an array of upper and lower respiratory conditions, such as chronic coughing and sneezing, ear infections, nasal discharge, and recurrent rhinosinusitis and bronchopneumonia, as well as seemingly unrelated conditions, such as exercise intolerance, cyanosis, hydrocephalus, *situs inversus* and infertility in older male dogs. What these conditions have in common is that they are either directly or indirectly caused by immotile, or dyskinetic cilia. In dogs with PCD, this defective functioning is the result of structural defects within the cilia themselves.

In general, the central strand of each cilium, or axoneme, consists of nine peripheral microtubule pairs (tubule A and B), or doublets, as well as two single microtubules located in the centre (see Fig. 1). Further, each microtubule possesses "arms" comprised of multiple polypeptides (called dynein arms) that stretch both inwards and outwards, but are always orientated clockwise towards the adjacent B microtubule of the next doublet. Lastly, each doublet is also connected to the adjacent doublets via proteinous structures called nexin links. Importantly, both the specific orientation of the dynein arms, as well as the securing of the doublets relative to each other, plays an integral role in allowing proper function; if either structural element is disrupted, the ability of the cilia to move in a synchronous, wave-like motion is impeded.

Whether because of shortened or absent dynein arms, or trans-positioning of the microtubules, dogs that are affected by PCD have cilia that are unable to move in a co-ordinated way, thus reducing their ability to move substances, such as mucus, through the airways and other cavities.

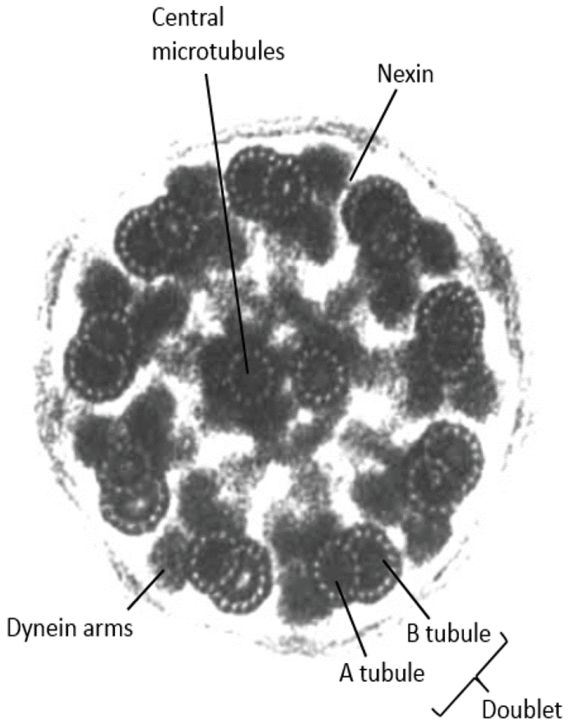


Fig. 1 - Cross-section of an axoneme of a clinically normal dog. Primary Ciliary Dyskinesia in the dog. Morrison et al. 1987.

In addition to causing respiratory congestion, this defective motion also has a negative impact on the respiratory element of a dog's immune system. As an initial defence against microorganisms and particles that are inhaled, respiratory epithelial cells are covered in a protective mucus layer, which traps any foreign elements that come into contact with it. As this mucus layer is constantly being generated by the secretory cells also lining the respiratory tract, the respiratory cilia must continuously move the current layer of mucus, along with any trapped particles, towards the pharynx,

where it can be swallowed and disposed of within the stomach. Any anomalies within the orientation or structure of the cilia that disrupt this balance between mucus secretion and removal would thus cause both congestion and a build-up of infectious material within the airways.

However, as PCD is by no means the only (or even the most likely) cause of respiratory infections, a thorough examination is necessary in order to rule out alternative causes, such as recurring pneumonia or canine distemper. Classically, this would include a physical examination, bloodwork (a CBC panel to determine whether mature neutrophilic leukocytosis are present), a nasal/bronchial mucous biopsy (specific lesions should be present in a high percentage of cilia from multiple locations), as well as determining whether the dog is up to date with all inoculations and parasite preventions, and whether there are any other pets at home that are experiencing similar symptoms.

Additionally, an electrocardiogram can be used to detect any abnormalities in heart function that might be caused by *situs inversus*, as well as a ciliary beat frequency and synchrony analysis to assess ciliary function. More recently, however, is the option of genetic testing. PCD is understood to be an inherited condition, and as a recessive trait, has been associated with the negative impact of inbreeding on genetic health.

Studies across different breeds have identified several recessive mutations within genes that code for the structural components of the axoneme, or pre-assembly factors of those components. One example is the C>T mutation located within the third exon of the CCDC39 gene, which encodes components of the dynein arms, spokes and cytoplasm. This single base pair change creates a premature stop codon within the gene, resulting in nonsense-mediated RNA decay.

In the event that a dog is diagnosed with PCD, the prognosis and treatment will largely depend on the severity of the symptoms and how well the dog responds to treatments. In less severe cases, simply providing routine exercise can be sufficient to maintain health, as the force associated with exhalation during rigorous exercise can help to promote mucus movement by inducing coughing and increasing respiration. In more severe cases, however, such as life-threatening bronchopneumonia episodes, supplementary oxygen therapy may be required, as well as the prescription of an effective antibiotic. In general, affected dogs should also be kept out of high ambient temperatures, as their reduced evaporative heat loss capacity through the lungs can result in hyperthermia and heat stroke. Finally, even in less severe cases, owners of dogs with PCD should observe their animals carefully, and schedule frequent check-ups with a vet. It is sadly not possible to ensure the survival of every dog with PCD, but for those that can recover, the correct combination of physical therapy, medication and owner vigilance can mean a prolonged, and even healthy, life.

The breeds most commonly affected by PCD include: Bichon Frise, Border Collie, Bull Mastiff, Chihuahua, Shar Pei, Chow Chow, Dalmatian, Doberman Pinscher, English Cocker Spaniel, English Pointer, English Setter, English Springer Spaniel, Golden Retriever, Gordon Setter, Long-haired Dachshund, Miniature Poodle, Old English Sheepdog, Newfoundland, Rottweiler and Staffordshire Bull Terrier.

Managing Pericardial Effusion in the Dog

(Proceedings)

L. Ari Jutkowitz, VMD, DACVECC

Pericardial effusion is defined as the accumulation of fluid within the pericardial space

Pericardial effusion is defined as the accumulation of fluid within the pericardial space. As the pressure within the pericardial space increases, right sided cardiac filling is impaired, resulting in decreased stroke volume with subsequent decreases in cardiac output and ultimately decreased oxygen delivery to the tissues (shock).

These manifestations of pericardial effusion are referred to as cardiac tamponade. Keys to the successful emergency management of dogs with life threatening pericardial effusion depends on early triage, a thorough physical examination, point of care diagnostic imaging techniques, and subsequent pericardiocentesis or placement of an indwelling pericardial drain.

Triage and Physical Examination in Pericardial Effusion

The most common presenting complaints from the owners of dogs with pericardial effusion and cardiac tamponade are lethargy, anorexia, collapse or syncope, abdominal distention, and dyspnoea. Major body systems assessment of the dog with pericardial effusion will likely reveal compromise to one or all of the major body systems. Assessment of the cardiovascular system may frequently reveal the following:

- Pale mucous membranes due to vasoconstriction and poor peripheral perfusion
- Slow CRT due to decreases in cardiac output
- Increased heart rate due to compensatory activation of the sympathetic nervous system
- Poor pulse quality due to decreased stroke volumes and low blood pressure

Assessment of the respiratory system will frequently reveal increased respiratory rate and effort.

Assessment of the central nervous system will frequently reveal a decreased level of consciousness secondary to decreased oxygen delivery to the brain. Any one or combination of these findings should necessitate movement to the treatment area for further assessment including full physical examination, measurement of blood pressure, oxygen saturation, cardiac rhythm (ECG), and placement of an intravenous catheter from which a small blood sample for packed cell volume PCV / total serum protein (TSP) / blood glucose $\pm$ venous blood gas and electrolytes can be rapidly acquired.

If the patient is stable, blood for CBC, serum biochemical profile, and coagulation profile or ACT should also be collected. Concurrently, a second team member will be able to collect a full medical history.

Physical examination should still be centred on the major body systems, but subtle findings supportive of pericardial effusion may be noted including:

- Jugular venous distention $\pm$ jugular pulses: due to right sided congestive heart failure.

- Muffled heart sounds and normal lung sounds: unlike pleural effusion which will frequently cause decreased heart and lung sounds, pericardial effusion will frequently only cause decreased heart sounds.
- Abdominal distention: ascites and hepatic engorgement may result from longstanding pericardial effusion (days) / cardiac tamponade due to right sided congestive heart failure. Abdominocentesis will frequently reveal a relatively clear fluid will low cellularity and a protein concentration greater than 25g/L but less than 35g/L most consistent with a modified transudate.
- Pulsus paradoxus: An inspiratory fall of arterial systolic blood pressure of more than 10mmHg resulting in variation in pulse intensity with respiratory cycle due to increased venous return during inspiration, increased right sided filling, shifting of the interventricular septum to the left with decreased left sided diastolic filling and subsequent decreased left sided stroke volume.
- Other physical examination findings specific to the underlying cause of the effusion such as fever in septic or fungal pericarditis.

Pericardial effusion causing cardiac tamponade should be HIGHLY suspected based on signalment, history, and physical examination findings, supported by diagnostic testing such as abdominocentesis and electrocardiography (± radiography) and confirmed through point of care diagnostic imaging techniques.

Diagnostic Techniques

Echocardiogram

Echocardiogram is the diagnostic test of choice for confirmation of the presence of pericardial effusion in the dog.

Many dogs with pericardial effusion have SEVERE cardiovascular compromise and can be on the verge of death. The stresses associated with radiographic imaging may put cause these patients to decompensate. Consequently, in the ideal world, radiographic imaging should be avoided initially.

The author has found that the presence of a small, portable ultrasound machine with a mid-range frequency transducer placed at the primary treatment station in the emergency room / treatment area to be of great utility for identifying conditions like pericardial effusion, pleural effusion, and to assess patients with acute abdomen for the presence of abdominal fluid. Echocardiographically, pericardial effusion appears as a hypoechoic space located between the hyperechoic pericardium and the right ventricular wall when viewed through the right cardiac notch. The presence of pericardial effusion provides excellent contrast to aid in the diagnosis of cardiac masses, however, pericardiocentesis should NOT be delayed in a patient with signs of shock simply to aid the diagnosis.

Thoracic Radiography

Thoracic radiography can be an extremely stressful procedure for dogs with cardiac tamponade. However, not all practices are equipped with ultrasound capabilities. If thoracic radiography is performed in dogs with suspected pericardial effusion, ventrodorsal positioning should be avoided. A dorsoventral projection can be acquired with minimal stress.

Lateral thoracic radiographs may also be performed. Supportive radiographic findings include an enlarged, globoid cardiac silhouette. Acute effusions may not cause severe enlargement of the cardiac silhouette because the pericardium has not had time to stretch. Concurrent pleural effusion may be present. The other primary differential for a globoid heart is dilated cardiomyopathy (DCM) or other underlying cardiac disease. Key findings to try to differentiate DCM from pericardial effusion include:

- Heart sounds: Heart sounds in dogs with DCM are frequently normal in contrast to the decreased heart sounds seen in pericardial effusion. A systolic murmur may be noted in dogs with DCM and is uncommon in dogs with pericardial effusion.
- ECG: Atrial fibrillation is common in dogs with DCM. Atrial fibrillation is uncommon in dogs with pericardial effusion. Electrical alternans may be seen in dogs with pericardial effusion.
- Cardiac Silhouette: The silhouette of the heart on thoracic radiographs of dogs with pericardial effusion tends to be extremely round with sharp borders. The silhouette of the heart in dogs with cardiomyopathy can be round, but often, there are still some dimples or "waist" associated with the divisions between the chambers and the borders of the cardiac silhouette tend not to be as sharp because of motion artifact.
- Pulmonary infiltrate: Pulmonary oedema is common in DCM and uncommon in pericardial effusion.
- Pulsus paradoxus: Common in pericardial effusion, uncommon in DCM.

Abdominocentesis: See above.

Electrocardiography

Assessment of ECG in patients with pericardial effusion may reveal sinus tachycardia ± ventricular arrhythmias. Ventricular arrhythmias may result from decreased myocardial oxygen delivery or aberrant conduction associated with the underlying cause of the effusion. QRS complexes <1mV in amplitude and the presence of electrical alternans (regular or irregular variation in QRS complex amplitude associated with the heart moving within the pericardium to and from the positive pole of lead II) are supportive of pericardial effusion.

Aetiology

Pericardial fluid accumulation and cardiac tamponade in the dog most often occurs secondary to a neoplastic process. Hemangiosarcoma (HSA) is most commonly identified in the region of the right atrium or right atrial appendage while chemodectoma (common in brachycephalic breeds) is most often identified at the heart base. Mesothelioma and any metastatic tumour are additional neoplastic causes. Although location and breed are frequently suggestive of tumour type, definitive diagnosis is dependent on a biopsy specimen.

Idiopathic pericardial effusion tends to be an inflammatory process and is frequently recognized in similar breeds to those that frequently develop HSA. Significant efforts in recent years have been directed towards developing diagnostic tests to help differentiate malignant from benign pericardial effusion (idiopathic). Pericardial fluid pH was initially thought to aid in making this differentiation, however, pericardial fluid pH has now been clearly shown to be of little diagnostic value. Recent evidence suggests that blood concentrations of cardiac troponin I (cTnI) are significantly higher in dogs with masses consistent with HSA than in dogs without evidence of an underlying cause (idiopathic).

Vitamin K1 antagonists (anticoagulant rodenticides and coumadin) can also result in pericardial effusion. Therefore; it is the author's practice to always perform an activated clotting time (ACT) or other point-of-care coagulation assessment at the cage side prior to pericardiocentesis. If significant coagulopathy is present and patient condition permits, correction of coagulopathy with blood products (fresh frozen plasma or fresh whole blood) is indicated prior to pericardiocentesis. Subsequent institution of Vitamin K1 therapy for 4 weeks is indicated.

Left atrial tear is an uncommon consequence of chronic mitral regurgitation and left atrial dilatation, however, it has been recognized as a cause of acute pericardial effusion in the dog. An infectious cause of pericardial effusion, although rare, is fungal disease (coccidiomycosis). Bacterial pericarditis and pericardial effusion secondary to trauma also occur, but are rare.

Numerous additional conditions such as congestive heart failure, uremia, decreased oncotic pressure, and a host of systemic inflammatory processes frequently result in small volume pericardial effusion accumulations without evidence of cardiac tamponade.

Pericardiocentesis

Pericardiocentesis can be a stressful procedure. Use of cardiovascularly sparing sedatives (narcotics and benzodiazepines) may alleviate patient stress and facilitate safe pericardiocentesis.

Numerous techniques have been described for pericardiocentesis in the dog including, but not limited to the use of a large-gauge over-the-needle catheter, through the needle catheter, and catheters placed using the Seldinger technique. Numerous commercial pericardiocentesis trays / kits are also available. The author prefers to use a 14-16g, 5.5" over-the-needle catheter (Abbocath T, Hospira Inc. Lake Forest, IL) with two additional small side-holes or a commercial multi-lumen intravenous catheter placed using the Seldinger technique (Arrow Triple Lumen Central Venous Catheter, Arrow International, Reading, PA). The former is much less expensive while the latter may be left in place for ongoing drainage.
ECG should be monitored during and after pericardiocentesis for the presence of arrhythmias induced by catheter-associated irritation of the epicardium and decreased myocardial oxygen delivery experienced during cardiac tamponade. Lidocaine should be readily available, as should a defibrillator.

Pericardiocentesis technique summary

- Pericardiocentesis is most often performed from the right hemithorax because injury to the left coronary artery is unlikely, and the cardiac notch is slightly larger.
- The patient can be positioned in sternal recumbency (preferred by most) or laterally.
- Full surgical preparation should be performed between the 2nd to the 8th ribs and from the mid-thorax to the level of the sternum.
- A fenestrated drape should be placed. Aseptic technique should be practiced at all times.
- The apex beat of the heart should be palpated (most often between the 4th and 5th ribs just above the costochondral junction) and lidocaine should be infiltrated locally off of the cranial edge of the rib (to avoid the intercostal neurovascular bundle).
- Ultrasound guidance can also be used to identify the optimal location for pericardiocentesis.
- A small skin incision (<5mm) should be made in the proposed insertion site and the catheter advanced through this incision (off the cranial edge of the rib). Upon the appearance of fluid in the flash chamber, the catheter and stylet should advanced together for 2-3mm and the catheter fed over the stylet into the pericardium.
- Initially, a small fluid sample should be placed in an ACT or clot tube. A sample retrieved from the ventricle should clot (unless the underlying condition is anticoagulant rodenticide intoxication) while one that has been in the pericardial space for any appreciable period of time should not.
- A fluid sample should be saved for cytologic analysis and culture and the pericardium should be evacuated.

Monitoring

Patient response to decompression of significant pericardial effusion is often very rapid and very gratifying as vital signs and physical examination findings improve dramatically. Monitoring for recurrence of fluid accumulation by frequent reassessment of major body systems, physical examination and echocardiography is useful. Placement of a central venous catheter and monitoring of central venous pressure can also be a useful technique in that re-accumulation of pericardial fluid will result in a rise in central venous pressure.

Prognosis

Prognosis for dogs with pericardial effusion will depend on the underlying cause of the disease. Surgical removal of a mass on the right atrial appendage will at least temporarily alleviate signs of recurrent pericardial effusion. Surgical removal of right atrial / appendage HSA followed by chemotherapy will prolong life in dogs with pericardial effusion. Pericardectomy will temporarily palliate clinical signs of pericardial effusion for most neoplastic processes, and will most often be curative for idiopathic pericardial effusion.

Thoracoscopic pericardectomy or creation of a pericardial window may have similar effects. Balloon pericardiotomy is currently under investigation as an alternative palliative procedure. Treatment with fresh frozen plasma, vitamin K1, and pericardiocentesis will be curative for dogs with anticoagulant rodenticide intoxication. Culture and sensitivity based antimicrobial therapy ± surgical debridement is indicated for the management of infectious pericarditis.

Dogs with left atrial tear secondary to chronic mitral valve regurgitation and left atrial dilation carry a guarded prognosis. Surgical repair of such a lesion has been described.

Conclusion

Triage and careful attention to physical examination findings supported by ancillary diagnostic tests and point-of-care diagnostic imaging are the keys to the rapid identification of pericardial effusion in the dog. Rapid identification of problems and institution of treatment will maximize the likelihood of a positive outcome.

References

1. Berg RJ, Wingfield W. Pericardial effusion in the dog: a review of 42 cases. J Am Anim Hosp Assoc 1984;20: 721-730
2. Bouvy BM, Bjorling DE. Pericardial effusion in dogs and cats. Part I. Normal pericardium and causes and pathophysiology of pericardial effusion. Compendium 1991; 13: 417-424.
3. Bouvy BM, Bjorling DE. Pericardial effusion in dogs and cats. Part II. Diagnostic approach and treatment. Compendium 1991; 13: 633-341.
4. Bonagura JD. Electrical alternans associated with pericardial effusion in the dog. J Am Vet Med Assoc 1981;178: 574-579.
5. Fine DM, Tobias AH, Jacob KA. Use of pericardial fluid pH to distinguish between idiopathic and neoplastic effusions. J Vet Intern Med 2003;17: 525-529.
6. Edwards NJ. The diagnostic value of pericardial fluid pH determination. J Am Anim Hosp Assoc 1996;32: 63-67.
7. Shaw SP, Rozanski EA, Rush JE. Cardiac troponins I and T in dogs with pericardial effusion. J Vet Intern Med 2004;18: 322-324.
8. Petrus DJ, Henik RA. Pericardial effusion and cardiac tamponade secondary to brodifacoum toxicosis in a dog. J AM Vet Med Assoc 1999;215: 647-648.
9. Weisse C, Soares N, Beal MW *et al.* Survival times for dogs with right atrial hemangiosarcoma following surgical resection with and without adjuvant chemotherapy. In press.
10. Jackson J, Richter KP, Launer DP. Thoracoscopic partial pericardiectomy in 13 dogs. J Vet Intern Med 1999;215: 529-533.
11. Dupre GP, Corlouer JP, Bouby B. Thoracoscopic pericardectomy performed without pulmonary exclusion in 9 dogs. Vet Surg 2001; 30:21-27.
12. Sidley JA, Atkins CE, Keene BW *et al.* Percutaneous balloon pericardiotomy as a treatment for recurrent pericardial effusion in 6 dogs. J Vet Intern Med 2002;16: 541-546.
13. Sadanaga KK, MacDonald MJ, Buchanan JW. Echocardiography and surgery in a dog with left atrial rupture and hemopericardium. J Vet Intern Med 1990; 4: 216-21.

Additional Information for Pericardial Effusion

Author – DR L L van der Merwe BVSc MMEDVET (Med)

Signalment for PE

- Older dogs - commonly neoplasia
- Large breed older dogs - R atrial haemangiosarcoma (HAS) most common
- Brachycephalic older dogs - Heart base tumour (chemodectoma)

Radiographic changes

A 2013 study demonstrated that radiographic changes are not that sensitive with the diagnosis of PE in50 dogs presenting with cardiac tamponade.

An enlarged heart (VHS), globoid heart and convex appearance of dorsocaudal silhouette showing 7 7.6 %, 41.9% and 57.1% sensitivity respectively. Specificity was lower at 47.8%, 40% and 35 % respectively. It is hypothesised if the study didn't select for patients progressed to cardiac tamponade the sensitivity may have improved. However as veterinarians we will see these patients when they are showing clinical signs so these cautions are applicable.

Cardiac Tamponade

It is vital to note that the development of cardiac tamponade is NOT a function of the volume of the pericardial effusion , but of the amount of elasticity (STRETCH) of the pericardial sac. If there is inflammation and fibrosis of the pericardium cardiac tamponade may occur with only a moderate amount of fluid accumulation.

The shape and size of the pericardial sac can be affected by several variables:

- Rate of accumulation of pericardial effusion
- Distensibility of the pericardium
- Pericardial disease may affect compliance of the pericardium

Prognosis

Patients with Right atrial haemangiosarcoma have short survival: days - weeks, those with chemodectoma survive 1-2 years . Idiopathic effusion may be recurrent and require a pericardectomy.

Causes

Approximately 60 – 70% of pericardial effusions occur secondarily to neoplasia. Haemagiosarcoma, chemodectoma and mesothelioms are the most common . Haemangiosarcoma accounts for 69% or cardiac tumours and 47% of pericardial effusions occur due to R atrial HSA

Approximately 20% of pericardial effusions are idiopathic.

Small occult neoplastic lesion can be missed and a neoplastic effusion misdiagnosed as idiopathic. In this situation cardiac troponin I can be tested. Cardiac troponins are an indicator of myocardia damage. Cardiac TnI is a sensitive and specific marker for myocardial damage and has use as an indicator of cardiac involvement in patients with hemangiosarcoma. cTnI has been validated for use in samples obtained from dogs. A plasma cTnI concentration > 0.25 ng/mL could be used to identify cardiac hemangiosarcoma in dogs with pericardial effusion (sensitivity, 81%; specificity, 100%).

Intercostal Nerve blocks

The intercostal nerves descend in the intercostal space along the caudal border of each rib, associated with the ventral branches of the intercostal artery and vein.

Conscious patients that require an intercostal nerve block for analgesia of rib fractures will likely require sedation with appropriate systemic drugs, such as opioid and benzodiazepine combinations. The block is performed as dorsally as possible, near the intervertebral foramen. With the needle perpendicular to the lateral aspect of the body, advance the needle onto the rib, and then walk it caudally until it enters the tissues behind the rib's caudal border. After aspirating the syringe to avoid intravascular administration, inject the local anesthetic. Repeat this procedure to block three intercostal nerves in front, and three caudal to the site of interest

How to clinically differentiate a large breed dog with DCM from a large breed dog with a pericardial effusion?

In the absence of an ultrasound machine the following pointers may assist.

- A dog presenting with pericardial effusion is generally I a good body condition – dogs with HCM show evidence of weight loss from cardiac cachexia.

HAEMORRHAGIC EFFUSION	TRANSUDATE EFFUSION	EXUDATE EFFUSION
Idiopathic PE	Congestive heart failure (Cats)	Bacterial pericarditis • Penetrtaing wound
Neoplasia • Haemangiosarcoma • Aortic Body Tumour (chemodectoma) • Mesothelioma • Ectopic thyroid carcinoma • Lymphosarcoma • Metastatic carcinoma	Peritoneopericardial diaphragmatic hernia	
	Hypoalbuminaemia	Fungal pericarditis *(not in SA)*
	Congenital pericardial cysts	FIP (cats)
Coagulopathy	*(transudate effusions less likely to cause tamponade in dogs)*	
Left atrial rupture		
Uraemia		

- If a dog with DCM is presenting with ascites it will probably also have a supraventriciular tachycardia with a cardiac arrhythmia due to atrial fibrillation and VPCs. Because of the VPCs, dogs with DCM will often have a significant pulse deficit. Dogs with a perdicardial effusion do not generally present with an arrhythmia but do have a sinus tachycardia and no pulse deficit.
- The cardiac shape may be more globoid (apple-like) in pericardial effusion than with DCM (not very sensitive)
- You may hear a soft heart murmur with DCM, you should not with a pericardial effusion.

References

1. Chun, R, Kellihan. HB, Henik. RA et al 2010 . Comparison of plasma cardiac troponin I concentrations among dogs with cardiac hemangiosarcoma, non-cardiac hemangiosarcoma, other neoplasms, and pericardial effusion of non-hemangiosarcoma origin. Journal of the American Veterinary Medical Association Vol 237 p:806–811
2. Cote, E. Schwarz L, Sithole F, 2013 . Thoracic radiograph findings for dogs with cardiac tamponade attributable to pericardial effusion. Journal of the American Veterinary Association. Vol 243 (2)pp: 232 -235
3. .DeFrancesco, T C. July 2013Management of Cardiac Emergencies in Small Animals . Veterinary Clinics of North America: Small Animal Practice Volume 43, Issue 4, pp 817-842
4. DVM 360 Local and regional anesthesia techniques, Part 2: Stifle, intercostal, intrapleural, and forelimb techniques. March 1, 2009 (previously published in Vet 360)

CPD Questions

Go to www.vet360.vetlink.co.za or download the new Vet360 App to answer the questions
CPD reserved for Vet360 subscribers (R360 per annum) Call 012 346 1590 or visit www.vet360.vetink..co.za to sign up

1. Which one of the sequelae to pericardial effusion listed below is INCORRECT?

a. Pressure within the pericardial space increases.
b. Left sided cardiac filling is impaired.
c. Decreased stroke volume.
d. Decreases in cardiac output.
e. Decreased oxygen delivery to the tissues.

2. Which one of the presenting complaints, observed by owners, is NOT consistent with a diagnosis of cardiac tamponade?

a. Lethargy.
b. Collapse or syncope.
c. Abdominal distention.
d. Polyuria and polydipsia.
e. Dyspnoea.

3. Which one of the parameters list below for assessment of the cardiovascular system is CORRECT?

a. Pale mucous membranes due to vasodilation.
b. Congested mucous membranes due to sympathetic response.
c. Congested mucous membranes due to peripheral pooling of blood.
d. Pale mucous membranes due to vasoconstriction and poor peripheral perfusion.
e. Pale mucous membranes due to increased stroke volume.

4. Which one of the clinical findings below is NOT consistent with a diagnosis of pericardial effusion?

a. Jugular venous distention with possible jugular pulses due to right sided congestive heart failure.
b. Muffled heart sounds and lung sounds.
c. Weakness due to poor perfusion.
d. Abdominal distention due to ascites and hepatomegaly.
e. Pulsus paradoxus a variation in pulse intensity with respiratory.

5. Radiographic changes to cardiac silhouette have been shown to be not that sensitive in diagnosing pericardial effusion. Several factors play a role. Which one of the factors listed below is NOT relevant?

a. Rate of accumulation of pericardial effusion.
b. Distensibility of the pericardium.
c. The type of fluid (viscosity) which accumulates plays a role in the development of cardiac tamponade.
d. Pericardial disease may affect compliance of the pericardium.
e. If there is inflammation and fibrosis of the pericardium cardiac tamponade may occur with only a moderate amount of fluid accumulation.

6. Which of the steps listed below to prepare for a pericardiocentesis is CORRECT?

a. Pericardiocentesis is performed on the RIGHT side.
b. The left coronary blood vessel is dorsally placed making it safe from injury.
c. The right coronary blood vessel is more prone to injury.
d. The coronary blood vessels are not at risk with this procedure.
e. Both left and right coronary blood vessels can easily be lacerated.

7. Which one of the preparation steps listed below for performing a pericardiocentesis is INCORRECT?

a. The patient positioning in sternal recumbency.
b. Centesis site is between the 6th and 10th ribs and from the mid-thorax to the level of the sternum.
c. Perform a local block with lidocaine off of the cranial edge of the rib in identified region.
d. A small skin incision (<5mm) should be made in the proposed insertion site.
e. An over the needle catheter is typically used.

8.Which one of the statements regarding pericardial effusion is INCORRECT?

a. Echocardiogram is the diagnostic test of choice for confirmation of the presence of pericardial effusion in the dog.
b. Pericardial effusion causing cardiac tamponade should be HIGHLY suspected based on signalment, history, and physical examination.
c. Many dogs with pericardial effusion have SEVERE cardiovascular compromise and can be on the verge of death.
d. The presence of pericardial effusion provides excellent contrast to aid in the diagnosis of cardiac masses.
e. Pericardiocentesis should be delayed if at all possible to assist in making a primary diagnosis.

9. Which one of the statements regarding pericardial effusion is INCORRECT?

a. Pericardial effusion appears very bloody but does not clot.
b. Approximately 40% of pericardial effusions are idiopathic.
c. Approximately 60 – 70% of pericardial effusions occur secondarily to neoplasia.
d. 47% of pericardial effusions occur due to R atrial HAS.
e. An increased plasma cTnI concentration could be used to identify occult cardiac hemangiosarcoma in dogs with pericardial effusion.

10. Which one of the statements regarding pericardial effusion is INCORRECT?

a. Pericardectomy will temporarily palliate clinical signs of pericardial effusion for most neoplastic processes.
b. Pericardectomy will temporarily palliate recurrent idiopathic pericardial effusion.
c. Older dogs large breed dogs will commonly have a neoplastic effusion.
d. In large breed older dogs R atrial haemangiosarcoma (HAS) most common.
e. In brachycephalic older dogs, Heart base tumour (chemodectoma) is most common.

Hill's
Transforming Lives

DIGESTIVE CARE

TURN GI ISSUES AROUND IN AS LITTLE AS 24 HRS

Hill's Prescription Diet GI Biome Food demonstrated clinical results in cats with constipation or diarrhoea[1] and dogs with diarrhoea[2] in as little as 24 hours.

Now in an upgraded dry formula for cats.

ActivBiome+

Ask about microbiome nutrition that's **A STEP AHEAD FOR THEIR BEST LIFE**

Helicopter/Biome/V360

[1]Wernimont, S.M., *et al.* Food with Specialised Dietary Fibre Sources Improves Clinical Outcomes in Adult Cats with Constipation or Diarrhoea (in a 2 Month Study). *FASEB J.* 2020;34(1). Some cats may require multimodal management. [2]Fritsch, D.A., *et al.* Food with Novel Fibre Blend Improves Clinical Outcomes and Changes Gastrointestinal Microbiome Metabolism in Dogs (in a 2 Month Study). *J Vet Intern Med.* 2019;33(5):2513.

pet remedy

natural de-stress & calming

KYRON
30 Years
SERVING THE VETERINARY INDUSTRY

Works immediately!

Aggression
Nervousness
Noise phobia
Separation
Anxiety
Fear

Available at selected Vets, Vet shops and online stores

www.kyronlabs.co.za
facebook.com/KyronLabs

Health and beauty for all animals®

KYRON
Kyron Laboratories (Pty) Ltd. Co. Reg. No. 1990/004442/07
29 Barney Road, Benrose 2094 South Africa
Tel +27 11 618 1544 | kyron@kyronlabs.co.za